IT ambidexterity: A competitive IT capability for high-tech SMEs

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I hereby that this thesis has not been and will not be, submitted in whole or in part to another University for the award of any other degree.

Signature……TAHIR ABBAS SYED…….

To my parents and my family, for all your love, support and constant encouragement

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Without doubt, the successful completion of my PhD would not be possible if I did not have support, encouragement, and guidance of many people in my life. I would like to take this opportunity to extend my sincere gratitude to all those who have provided me with help and encouragement, who have always been available to support and guide and without whom it would have been almost impossible for me to overcome the challenges of this doctorate candidacy.

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Summary

The proliferation of information technology (IT) tools has pervaded industry environment with products that are becoming differentiated, smarter and competitive every day. Following this trend, high-tech small and medium enterprises (SMEs) face precarious pressures to enhance their technological competence continuously to survive. They are required to embed IT ambidexterity – the ability of the firm to simultaneously refine their existing technologies (IT exploitation) and search new technological solutions (IT exploration) – into their organisational strategy.

Owing to limited slack resources and immature firm routines, processes, administrative hierarchy, organisational systems and operational experiences, a key challenge for high-tech SMEs arise in enabling and managing the simultaneous pursuit to exploit existing technology in the short-term and explore new technological breakthroughs for the long-term. This dissertation posits IT ambidexterity as a competitive IT capability and sets out to investigate what are the enabling mechanisms that allow high-tech SMEs to become IT ambidextrous and whether IT ambidexterity is, in fact, a relevant strategy to enable superior performance in high-tech SMEs of the United Kingdom. A survey based dataset of 292 high-tech British SMEs are empirically analysed to test the proposed hypotheses. The study consists of an introduction, a conclusion, and in between four empirical papers, which address specific research gaps in the extant IT ambidexterity literature.

Chapter two examines the role of leadership and organisational configuration in facilitating IT ambidexterity and analyses its implications on projects' performance. The empirical analysis suggests that both leadership and organizational configuration play a vital role to enable IT ambidexterity, which in turn improves project performance. Chapter three focuses primarily on the role of high-tech SME leaders to understand if leadership decision-making styles initiate IT ambidexterity and examines how and when a particular leadership decision-

making style can be more effective by considering organisational diversity and shared vision as two important organisational contingencies. The findings suggest leadership participative as well as directive decision-making styles enable IT ambidexterity; however, the participative decision-making style is more effective with heterogeneous firm members, and the directive decision-making style is preferred when a shared vision is dominant among firm members. Moreover, results show that IT ambidexterity significantly enhances firm performance. Chapter four explicates the effect of IT ambidexterity on IT department performance. This chapter draws on a combination of the resource-based view and contingency theory to investigate the moderating effects of a firm's internal and external contingencies on the IT ambidexterity-IT department performance relationship. The findings show that the positive effect of IT ambidexterity on IT performance is amplified for the firms with more resources and at higher levels of environmental dynamism, complexity and munificence. Interestingly, the results show that the performance implications of IT ambidexterity are not firm age-dependent. Chapter five develops on the IT-enabled organisational capabilities perspective to examine whether IT ambidexterity enhances speed to market – referred as how quickly product is made available in the market after the product definition stage. This chapter posits operational agility as an IT-enabled organisational capability and that formalisation plays a role of moderator in this equation. The developed model is further examined under the varying conditions of environmental complexity. The empirical analysis suggests that the effect of IT ambidexterity on speed to market is partially mediated by operational agility and the operational agility has a greater impact on speed to market in environments that are more complex. While formalization does not moderate the link between IT ambidexterity and operational agility, our results reveal that this moderation effect is evident and significant in complex environments.

Despite of its importance, IT ambidexterity is an IT concept only proposed and investigated very recently, for which our understanding is extraordinarily limited in the field of IS. Altogether, this thesis contributes to the embryonic stage of IT ambidexterity literature by providing an in-depth understanding of the enabling mechanisms and consequences of IT ambidexterity in high-tech SMEs. The findings of this thesis contribute to the debate surrounding how to manage and organise for IT exploitation and IT exploration simultaneously within the same firm. In contrast to prior arguments that ambidexterity can only be enabled with separate exploration and exploitation organisational units, the mechanisms irrelevant to high-tech SMEs, this study highlights the idiosyncratic roles of firm leaders and configurations to develop IT ambidexterity. In addition, against the theoretical concerns that due to resource limitations ambidexterity might become a performance-constraining strategy for high-tech SMEs, this study illustrates that IT ambidexterity not only directly impacts performance outcomes of high-tech SMEs but also provide a foundation for developing a higher-order operational capabilities.

In conclusion, this study responds to the call for greater attention on developing a competitive IT framework. In contrast to several other constructs (e.g. IT spending, IT development, and IT possession) that may not necessarily create competitive advantage due to imitability and substitutability, this study theorises IT ambidexterity as a distinct and valuable IT capability that is hard to emulate. This study contributes to the Information Systems research by clearly identifying the enabling mechanism and impacts of IT ambidexterity, thus, serves as a foundation stone for future research in this important and growing area of research.

CHAPTER 1

INTRODUCTION

Chapter 1 | Introduction

1. The Phenomenon Studied

The economic turbulence and globalisation of markets in recent years have defied small and medium enterprises (SMEs) to remain competitive when there are growing numbers of firms chasing dwindling number of orders from customers. In particular to high-tech SMEs, these undeniable difficult situations coincide simultaneously with rapid developments in the field of information technology[1] (IT) that burden organisations with immense expenditures that are required to keep up with IT advances. For instance, Wesabe, a high-tech SME that created a website to help people manage their personal finances, was soon out of market due to a better designed website by an incumbent rival Mint (Hedlund, 2012). To harvest the full potential of the IT expenditures, many firms speculate about how to maximize the competitiveness from IT resources to face the increased competitive intensity and frequent changes in product/process technologies. To obtain and to maximize the value from IT investments, existing literature called to develop IT competitive frameworks that may assist firms to leverage their IT resources to enhance organisational competitive position (Nambisan, 2013). IT paradox theory also highlights a related concern asserting that as the power and ubiquity of IT resources grow, its strategic importance diminishes (Carr, 2003). Researchers argue that IT paradox may not be the matter of IT itself, it is due to the lack of mechanisms and competitive frameworks through which IT value is being realised (Devaraj and Kohli, 2003). With the proliferation of IT tools and intensified market rivalry, it has become important for high-tech SMEs to understand how to leverage IT resources in delivering competitive advantage. Information Systems (IS) literature strives to comprehend the role of IT as an

[1] In this research, the term information technology (IT) refers to the technologies used to store, retrieve, transmit, utilise and manipulate data in a business context (Lin & Lin 2008).

operant resource for competitiveness in order to provide practitioners with advice and procedural guidelines on how to develop, implement and leverage IT (Nambisan, 2013; Durmuşoğlu and Barczak, 2011; Chandrasekaran et al., 2012).

In the modern digital era, the fast-changing customer preferences and technological breakthroughs present high-tech SMEs with a profound dilemma: How can high-tech SMEs sustain their competitive positioning with existing technologies while simultaneously innovating better technological solutions?

2. Theoretical Motivations

The literature on organisational learning identifies two distinct ways for organisations to leverage their resources and capabilities: exploitation and exploration (March, 1991; Levinthal and March, 1993). Exploitation refers to the efficiency, refining and enhancement of existing organisational resources through known processes, whereas, exploration relates to searching, experimenting and innovating potential resources to create new capabilities and opportunities (March, 1991). More recently, scholars highlight the synergistic effect of pursuing both activities simultaneously, which is known as ambidexterity (He and Wong, 2004; Gibson and Birkinshaw, 2004; Jansen et al., 2006; Lubatkin et al., 2006). The literature has recognised the ambidexterity orientation that balances exploration and exploitation activities of key organisational resources to deliver competitive advantage and long-term organisational survival (Raisch et al., 2009; He and Wong, 2004; Auh and Menguc, 2005).

The same concept has steadily expanded in IS research, defining IT ambidexterity as the ability of the firm to undertake exploitation and exploration of IT resources and practices simultaneously (Lee et al., 2015; Heckmann, 2015; Gregory et al., 2015; Mithas and Rust, 2016). IT exploitation refers to a continuous improvement in existing technological practices, whereas, IT exploration is concerned with introducing novel and innovative technological

solutions (Lee et al., 2015) i.e., Global Value System by Haier that was able to achieve processes synchronization and check the alignment between requirements and constraints of different departments so that the outcomes of planning were accurate and feasible (Huang et al., 2012). In accordance with resource-based view (RBV) theory (Barney, 1991), IT ambidexterity develops a socially complex and imperfectly imitable resource (Mithas and Rust, 2016) that generates competitive advantage and delivers better performance (Subramani, 2004; Lee et al., 2015). Particularly, ambidexterity that balances exploration and exploitation activities within the same firm is argued to be highly desirable by small firms as they cannot afford like large firms to invest into huge separate units where they independently focus on exploration and exploitation (Chang and Hughes, 2012). This research posits IT ambidexterity as a distinct and valuable IT capability for high-tech SMEs to develop a competitive advantage.

2.1 Central construct

The table below provides an overview of the key constructs and definitions used in this thesis.

Construct	Definition
IT exploitation	Exploitation is associated with "refinement, selection, production and efficiency" (March, 1991: 71). Thus, in this research, IT exploitation refers to the ability of the firm to refine and extend skills and capabilities of existing technology continuously. IT exploitation asserts a commitment to existing technological resources and ensures the survival of an organisation in an existing competitive marketplace.
IT exploration	Exploration is associated with "experimentation, variation, risk-

	taking and search" (March, 1991: 71). Thus, in this research, IT exploration refers to the ability of the firm to experiment, innovate and search for the new technologies that firms do not possess; measure their perceived outcomes for the firm, adopt new technologies to facilitate new business activities and transform existing capabilities beyond limitations of currently applied IT solutions.
IT ambidexterity	IT ambidexterity has been defined as the ability of a firm to pursue both IT explorative and IT exploitative strategies at the same time (Lee et al., 2015), balance short- and long-term technological objectives (Heckmann, 2015), explore new technological opportunities while simultaneously exploiting existing IT solutions (Mithas and Rust, 2016) and the capacity to manage two inconsistent objectives equally well (Gregory et al., 2015).

Table 1: Central constructs

2.2 State of IS research on IT ambidexterity

Since the seminal work of ambidexterity pioneer March (1991), the research on ambidexterity have increasingly come to dominate in a number of literature streams including strategic management, organisational adaptation, organisational learning, technological innovation and organisational design (Raisch et al., 2009; He and Wong, 2004; Gibson and Birkinshaw, 2004; Smith and Tushman, 2005; Jansen et al., 2006; Auh and Menguc, 2005). Some of the nascent work in IS literature has started to examine various notions of IT ambidexterity i.e. (Gregory et al., 2015; Lee et al., 2015; Mithas and Rust, 2016). The careful examination of literature on IT ambidexterity reveals major gaps in the extant literature.

2.2.1 Mechanisms to develop IT ambidexterity

Given the embryonic stage of IT ambidexterity, the literature on IT ambidexterity seems to have neglected to identify the mechanisms that may assist firms to enable this competitive capability, particularly in SMEs. This literature gap is noteworthy because SMEs, same as large firms, face competitive pressures (Lubatkin et al., 2006) to enable and sustain ambidexterity. However, SMEs differ from large firms with limited slack resources, immature firm routines and processes, administrative systems hierarchy and operational experiences, which allow large firms to enable ambidexterity (Li et al., 2014). Given that high-tech SMEs survival may depend upon continuous and simultaneous pursuit of technological resources (Chandrasekaran et al., 2012), it becomes critical to unveil how SMEs cultivate simultaneous pursuit of competing activities. Moreover, the limited research that examines the antecedents to ambidexterity in SMEs do not consider industry dynamics (role of firm's external environments i.e., complexity, uncertainty, market rivalry etc.) and contextual factors (role of firm's internal factors i.e., team heterogeneity, level of shared vision, working structure and routines etc.). Thus, fail to answer when and how identified antecedents influence ambidexterity.

2.2.2 Multi-level approach

Most of the ambidexterity studies have focused on the business unit level, however, Birkinshaw and Gupta (2013) highlight the multi-level complexities of ambidexterity that drops down from a higher level to lower level in the firm. Thus, resolving ambidexterity at one level of the firm may create a new predicament at the lower level. Raisch et al. (2009) also highlight the similar research gap in ambidexterity literature pointing out that ambidexterity studies often adopt a fragmentary or a piecemeal approach, neglecting exploitation-exploration tensions across different levels of the firm. This approach results in

an unclear understanding of whether the initiating mechanisms are complementary or substitutes (Chandrasekaran et al., 2012).

2.2.3 IT ambidexterity to performance linkage

Research on IT ambidexterity has steadily expanded since Subramani (2004) recognised this phenomenon as one of the key sources of competitive performance in supply chain management systems. Although, advances in the strategic management of IT resources has recognised IT ambidexterity as the socially complex and ambiguous resource that can protect firms against resource imitation, transfer and substitution (Mithas and Rust, 2016), both theoretical and empirical studies are scant. The theoretical study by Gregory et al. (2015) highlight the implications in IT transformation programs. Likewise theoretical studies, empirical studies that test the performance impacts of IT ambidexterity are only few, i.e. studies by Lee et al. (2015), Mithas and Rust (2016) and Leidner et al. (2011). Lee and colleagues found a positive impact of IT ambidexterity on organisational agility through a mediated effect of operational ambidexterity (Lee et al., 2015). Mithas and Rust highlight the role played by IT dual strategy (cost reduction and revenue expansion) and IT investments in influencing profitability and firm market value (Mithas and Rust, 2016). Finally, Leidner and colleagues highlight the superior performance of information sciences ambidextrous strategy in their post-hoc analysis only (Leidner et al., 2011). However, these studies have some shortcomings. The study of Lee et al. (2015) highlight only the assistive role that IT ambidexterity plays in developing firm-level capabilities and not the direct effect on performance measures, Mithas and Rust (2016) study only examines the secondary sources of data for analysis and Leidner et al. (2011) findings are based on a very limited number of ambidextrous firms. Moreover, a research gap remains in moving research from *whether* simultaneous pursuit of IT exploitation and IT exploration influences performance to *when*

and *how* IT ambidexterity influence performance (Mithas and Rust, 2016; Markides, 2013; Iyengar, 2007).

2.2.4 Role of firm leaders

Many studies e.g. (Smith, 2014; Li et al., 2014; Turner et al., 2013; Cao et al., 2010; Raisch and Birkinshaw, 2008; Jansen et al., 2008; Lubatkin et al., 2006) highlight the challenges associated to and critical role of firm leaders in managing the paradoxical demands of exploitation and exploration. As the routines, structures, processes and skills required for exploitation are fundamentally different from those required for exploration (March, 1991),. O'Reilly and Tushman (2013) and Chandrasekaran et al. (2012) argue that firm leaders at strategic level have to orchestrate the allocation of resources, yet how leaders manage and embrace the strategic paradox needs further clarification (Birkinshaw and Gupta, 2013; Raisch and Birkinshaw, 2008; Cao et al., 2010; Li et al., 2014).

3. Research questions, research objectives & research contributions

This dissertation posits IT ambidexterity as an IT leveraging competence and sets out to address the aforementioned literature gaps by investigating the following overarching research problem:

> *What organisational factors allow high-tech SMEs to enable IT ambidexterity, and whether IT ambidexterity is, in fact, a relevant strategy to enable superior performance in high-tech SMEs?*

And the research questions derived from the research problem are as follows:

- *RQ1: what are the enabling mechanisms for firms to develop IT ambidexterity?(Chapter 2)*
- *RQ2: Does IT ambidexterity influence firm's project performance? (Chapter 2)*

- *RQ3: How might different decision-making styles influence high-tech SMEs' leaders to enable IT ambidexterity? (Chapter 3)*
- *RQ4: How does organisational diversity and shared vision influence the strength of the relationship between leadership decision-making styles and IT ambidexterity? (Chapter 3)*
- *RQ5: How does IT ambidexterity affect IT performance? (Chapter 3)*
- *RQ6: How do firms' internal and external contingencies moderate the IT ambidexterity-IT performance relationship? (Chapter 4)*
- *RQ7: How does IT ambidexterity effect speed to market within a firm? (Chapter 5)*
- *RQ8: Would the relationship between IT ambidexterity and an IT-enabled mechanism to enhance speed be strengthened in the firms that are formalised? (Chapter 5)*
- *RQ9: Whether environmental complexity influences the role of IT-enabled mechanism in delivering speed to market? (Chapter 5)*

4. Methodology

4.1 Empirical context and data collection

The target sample for this study consisted of 1000 high-tech SMEs (up to 249 employees) in the United Kingdom (UK), all of which lists in the FAME database. This database provides the most comprehensive listing of UK companies and contact information. Our sample covers a range of high-tech SMEs e.g. precision equipment manufacturers, computer and electronic product manufacturing, control instrument manufacturing, telecommunication, medical equipment and supplies manufacturing, and optics apparatus, all of which are included in NAICS 2012 industry classification under codes 33,51 and 54.

High-tech SMEs is an important context of study in IS literature for several reasons. First, High-tech is one of the most rapidly evolving sectors among SMEs (Warren and Hutchinson, 2000; Tsai and Yang, 2013). The continuous development in this sector, thus, requires a state-of-the-art research support. Second, the economic significance of high-tech SMEs has been widely recognised internationally due to high demand and export turnovers (Oke et al., 2007; Crick and Spence, 2005). Third, due to technological changes and survival stress, high-tech SMEs need to react rapidly, develop mechanisms to quickly assess opportunities and allocate resources to benefit from them (Crick and Spence, 2005). Such dynamic and demanding environments may provide an important setting to test the influence of IS strategies. Thus, the role played by competitive IT framework becomes a key attribute in high performing high-tech SMEs (Crick and Spence, 2005). Fourth, focusing particularly on high-tech SMEs may also contribute to reducing the potential variance caused by industry effect (Tsai and Yang, 2013). Finally, a high-tech sector in SMEs has a strong technological innovation imperative and are expected to employ approximately 40 percent of high proficiency workers i.e. programmers, scientists and engineers (Bharati and Chaudhury, 2015), thus, contributing significantly to national gross domestic product (GDP) growth. The choice of UK as an empirical setting is for several reasons. UK government has placed significant emphasis on high-tech SMEs development by introducing major initiatives e.g. The Tech City, Living Innovation (Department for Business Innovation Skills, 2011) and ranks 9th in the world in the 2009-2013 innovation index (Economist Intelligence Unit, 2009). Moreover, UK is, apart from USA and Taiwan, one of the most important supply centers of high-tech products in the world (Tsai and Yang, 2013; Oke et al., 2007). As the annual report on European SMEs states, UK high-tech SMEs post the strongest combined performance in value-added and performance growth (Muller et al., 2014). Based on aforementioned reasons,

UK high-tech SMEs represent an appealing and critical context in which to examine our research objectives and expand our understanding of IT ambidexterity.

We used a survey questionnaire as the data collection instrument to test our hypotheses. In an effort to improve content validity and response rates, the survey questionnaire was designed, formulated, and implemented in a manner which closely followed the recommendations of Podsakoff et al. (2003). After designing and refining the questionnaire, we directly e-mailed questionnaire to the key respondents who agreed to participate in our study.

5. Dissertation structure

Chapter 2 draws on leadership situational theory, control theory and organisational ambidexterity theory to develop a conceptual model that theorises leadership versatility and configurational flexibility to assist firms in enabling the simultaneous pursuit of IT exploration and exploitation activities. This chapter further analyses the influence of IT ambidexterity in attaining superior new project performance in high-tech SMEs.

Chapter 3 investigates the role of SME firm leaders in enabling IT ambidexterity. This chapter focuses on leadership decision-making styles (directive decision-making and participative decision-making) as key attributes to manage the resource orchestration. Moreover, drawing on the contingency theory of leadership, it further examines how and when leadership decision-making styles are beneficial by considering organisational diversity and shared vision as two important contingencies. Finally, this chapter highlights the implication of IT ambidexterity in enhancing high-tech SMEs' business performance.

To explicate the effect of IT ambidexterity on IT department performance, chapter 4 draws on a combination of the RBV and Contingency theory to develop a conceptual framework that investigates the moderating effects of a firm's internal and external contingencies on the IT ambidexterity-IT performance relationship.

Chapter 5 draws on the theory of IT-enabled organisational capabilities perspective; this Chapter proposes that IT ambidexterity enhances speed to market by facilitating operational agility and that organisational formalisation plays a role of moderator in the relationship between IT ambidexterity and operational agility. The proposed model is tested under varying conditions of environmental complexity.

Chapter 6 finalises and concludes this dissertation by discussing the theoretical and practical contributions accomplished through this research and points out research limitations and future research avenues. Figure 1-1 summarises all the dependent variables, independent variables, moderators, and mediators used in dissertation chapters.

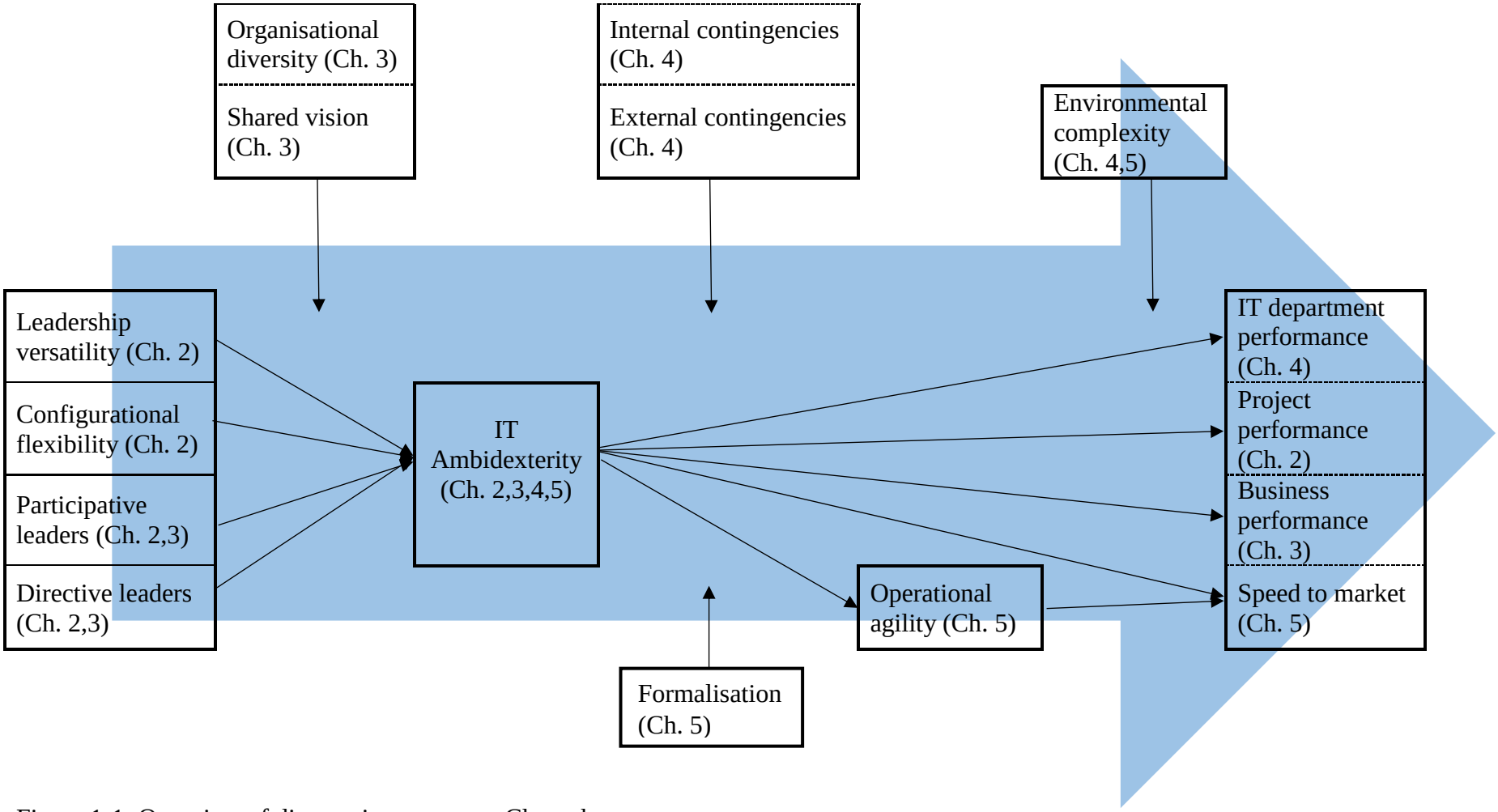

Figure 1-1: Overview of dissertation structure, Ch. = chapter

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CHAPTER 2

Chapter 2 | IT ambidexterity: Antecedents and performance impact in projects performance of high-tech SMEs

Abstract

Sustaining the IT-based competitive advantage is difficult and requires of exploring and exploiting new IT resources in the market. However, there has been limited attention to mechanisms the enable firm to develop this IT capability. This study examines the role of leadership versatility and configurational flexibility in facilitating IT ambidexterity and tests whether IT ambidexterity is, in fact, a relevant strategy to enable superior project performance in a sample of 292 high-tech UK SMEs. The empirical analysis suggests that leadership versatility and configurational flexibility assist firms in developing IT ambidexterity and that IT ambidexterity is indeed a significant contributor to enhance projects performance. We also find that IT ambidexterity partially mediates in the impact of leadership versatility on project performance and fully mediates the relationship between configurational flexibility and project performance.

Keywords*:* IT ambidexterity, leadership versatility, configurational flexibility, high-tech SMEs, project performance.

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1. Introduction

The life cycle of products and services (in short, products) is shrinking; therefore, the importance of developing new products more quickly and with the right specifications, so as to satisfy customer demand, is becoming more and more evident for firms to compete and survive in times of high market rivalry (Bloch et al., 2012). Thus, firms make massive investments to ensure quality, reduce costs and enhance the productivity of the products development process, also referred as project performance (Chandrasekaran et al., 2012). To enhance project performance, firms may depend on many organisational resources, but more importantly on information technology[2] (IT) (Nambisan, 2013). In fact, O'Mahony et al. (2003) found that over 90% of the senior executives in new projects believed IT as the key enabler of project's success. Perhaps, this explains why firms routinely make massive investments in IT (i.e. enterprise resource planning, computer-aided manufacturing, computer-aided engineering) to enhance projects' performance.

Firms face continuous pressures to explore new IT solutions at the same time exploit available IT resources to sustain high project performance. IT ambidexterity – defined as the ability of firms to exploit their existing technological resources and practices (IT exploitation) and explore new technological solutions (IT exploration) simultaneously (Lee et al., 2015) – has been recognised as a IT capability to enhance agility and enable sustainable competitive performance (Lee et al., 2015; Sambamurthy et al., 2007). For instance, Mettler-Telodo – a Swiss market leading company for producing mechanical balances used in scientific measurement – simultaneously pursued exploitation and exploration of their IT resources to survive the technological shift from mechanical balances to electronic balances (O'Reilly and Tushman, 2008). Firms that can enable, develop and routinize the practices of IT ambidexterity not only enhance their competitiveness in existing product markets but may

[2] The term information technology (IT) refers to the technologies used to store, retrieve, transmit, utilise and manipulate data in a business context (Lin & Lin 2008)

also develop new markets. For example, Harris Cooperation, which started in 1895 with manufacturing only printing press, exploited their IT resources to meet the present industry demands of printing presses at the same time explored new technological solutions to develop new markets. Harris Cooperation is now an excelling firm in providing a diverse range of electronic equipment for tactical communication, space and intelligence systems, healthcare, and environmental solutions (https://www.harris.com/solutions).

However, we have limited understanding of how IT ambidexterity may affect the project performance of the firms. Prior Information Systems (IS) literature has only a handful of studies that focus on the implications of IT ambidexterity on performance measures. For example, Lee et al. (2015) identify the role of IT ambidexterity in enhancing organisational agility, while, Chi et al. (2017) and Mithas and Rust (2016) highlight its moderating effects. Moreover, none of the studies on IT ambidexterity has examined the enabling mechanisms for this IT capability. Although, the studies of Lee et al. (2016), Mithas and Rust (2016) and Chi et al. (2017) highlight the competitive significance of IT ambidexterity, it is important to know how firms can enable this capability. Thus, our study attempts to fill this theoretical gap by addressing our first research question: 1) what are the enabling mechanisms for firms to develop IT ambidexterity? To test whether IT ambidexterity is in fact a relevant strategy to enable superior project performance leads to the second research question of this paper: 2) Does IT ambidexterity influence firm's project performance? We test our developed hypothesis to answer these research questions using partial least squares (PLS) path modelling, a variance-based structural equation modelling (SEM) technique, with survey data from a sample of 292 high-tech small and medium enterprises (SMEs) in the United Kingdom (UK).

This study contributes to the Information Systems (IS) research by enhancing our understanding of enabling mechanisms for IT ambidexterity. Second, we identify IT ambidexterity as a valuable IT capability that enhances project performance.

The rest of the paper is organised as follows. Next section presents the theoretical background and the hypotheses development that explains the proposed organisational theory. The research methodology section explains the sample, data and measures of this study. After that, the empirical analysis and findings are presented in the empirical analysis section. The paper concludes with a discussion of the findings and suggestions for future research.

2. Literature review

2.1. Organisational ambidexterity and IT ambidexterity

Ambidexterity means being adept at using both hands with equal ease. This concept is increasingly being used in the organisational context to represent the ability of an organisation to simultaneously balance differing and often competing trade-off situations (Gibson and Birkinshaw, 2004). In the management literature, ambidexterity is captured by different trade-off situations, such as the joint pursuit of incremental and discontinuous innovation (Smith and Tushman, 2005), exploitation and exploration (March, 1991), alignment and adaptability (Gibson and Birkinshaw, 2004) or efficiency and flexibility (Adler et al., 1999). However, the most commonly used and widely accepted trade-offs in the ambidexterity literature are between exploitation and exploration (Benitez et al., 2017; Raisch and Birkinshaw, 2008; O'Reilly and Tushman, 2008; Kang and Snell, 2009). Exploitation is associated with "refinement, choice, production, efficiency, selection, implementation, execution", whereas, exploration is captured by terms such as "search, variation, risk taking, experimentation, play, flexibility, discovery, innovation" (March, 1991: 71).

In this paper, we focus on IT and define IT ambidexterity as the firm's ability to pursue IT exploitation and IT exploration activities simultaneously (Lee et al., 2015). IT exploitation asserts a commitment to the existing organisational resources and ensures the survival of an organisation in the competitive marketplace helping with tuning existing resources. In other words, IT exploitation is attaining the optimum outcomes of existing IT resources and applications to satisfy the present needs of the firm. IT exploration, on the other hand, focuses on learning and knowing about the new technologies that firms do not possess, measuring their perceived outputs for possession, adopting new technologies to facilitate new business activities, and transformation of existing capabilities beyond limitations of currently applied IT solutions.

2.2. Antecedents of IT ambidexterity

The careful examination of IS literature reveals that the antecedents to IT ambidexterity have not yet been identified. The antecedents necessitate an understanding of how firms mitigate the conflicting demands to enable and sustain IT ambidexterity with the right levels of IT exploration and IT exploitation. Which is challenging because the outcomes of these activities differ in terms of timing and variability (March, 1991). Moreover, excessive focus on IT exploitation for short-term performance could lead to 'competency trap', in which exploitation drives out exploration. Similarly, the excessive focus of IT exploration may lead to 'failure trap', in which exploration drives out exploitation (O'Reilly and Tushman, 2008; Kang and Snell, 2009). In such paradoxical situations, the ability of the firm leader to make clear and consistent decisions becomes critical for firms in evading these traps (Smith, 2014; Chandrasekaran et al., 2012; Smith and Tushman, 2005). For example, Polaroid's decision to exploit their analog technology without exploring digital technology at the same time resulted in the loss of its market share (Tripsas and Gavetti, 2000). In other words, the decision-making approach of the leaders in resource allocation, instructing, guiding and supporting

firm members to leverage IT exploitation and IT exploration simultaneously signifies a key antecedent to ambidextrous orientation.

The ambidexterity literature suggests that the routines, structures, processes and competencies required for exploitation are fundamentally different from those required for exploration (Gibson and Birkinshaw, 2004; Tushman and O'Reilly III, 1996). Exploitation prospers in a mechanistic configuration and tightly-coupled systems that support path-refining behaviour (Kang and Snell, 2009), referred in this study as a formal configuration. Exploration, on the other hand, sprouts in an organic configuration and loosely-coupled systems that support path-breaking behaviour (Kang and Snell, 2009) referred in this study as an informal configuration. The formal configuration has distinctive boundaries, enlisted priorities, detailed rules and standardized routines, whereas, the informal configuration has limited routines that offer only priorities, vision and boundary conditions to direct the actions of individuals.

2.2.1. Leadership versatility

The prior IS literature highlights the critical role of firm leaders in IT acquisition, IT development, IT transformation and IT implementation projects (e.g. (Schwartz and Zozaya-Gorostiza, 2003; Bassellier et al., 2003; Gregory et al., 2015), however, the leadership role in developing an IT ambidextrous firm remains scant. Ambidextrous firms demand "senior leadership to support these contradictory strategies simultaneously" (Smith and Tushman, 2005: 388). In a qualitative study to understand how leaders manage the paradoxes of exploitation and exploration, Smith (2014) identifies that firm leaders address these tensions through a pattern of decision-making behaviour. As the influence of decision-making style is an important determinant of decision-making behaviour (Henderson and Nutt, 1980), we identify two well-vetted and rudimentary leadership decision-making styles – directive leaders and participative leaders – based on the seminal work of Vroom and Yetton (1973).

Directive leaders provide team members with a framework for decision-making and they act in alignment with the superior's vision, whereas, participative leaders make joint decisions with their employees (Martin et al., 2013; Vroom and Yetton, 1973).

Considering the complexity of IT ambidexterity, we believe a single leadership style may not promote the dual pursuit effectively. For instance, Gregory et al. (2015) identify six paradoxes that managers need to resolve in a case study of large IT transformation program in a commercial bank. They suggest managers "to employ ambidextrous resolution strategies to ensure short-term IT contributions and continuous progress of IT projects" (Gregory et al., 2015: 57). Thus, we posit that leadership versatility in managing the combination of directive and participative leadership decision-making approaches flexibly applied to the changing requirements of IT exploitation and IT exploration can be more effective. Drawing on the prior literature on decision-making behaviours, we conceptualize leadership versatility as the ability of the leaders to continually adjust their decision-making behaviour, deftly applying the right approach, to the right degree, for the circumstances at hand (Kaplan and Kaiser, 2003). Leadership versatility represents a high-order construct reflecting mastery of specific and opposing behaviours (e.g. decision-making) across situations (Kaplan and Kaiser, 2003).

The extant literature on ambidextrous leadership behaviour in IS and innovation management literature show higher performance implications for adopting a combination of leadership behaviours rather than focusing on one. For example, Han et al. (2016) identify that the ambidextrous leadership influence on team innovation is significantly stronger than single leadership. Likewise, in a qualitative study of an IS implementation project in the financial services industry, Gregory and Keil (2014) show that a combination of bureaucratic leader and collaborative leaders have better propensity to implement control ambidexterity (formal and informal control). Gregory's work is intriguing because it suggests that managers with disparate management skills (one with bureaucratic style and other with collaborative

style) may have to work together to promote ambidextrous behaviour. However, Gregory's work leaves open the question of whether a single individual can promote ambidexterity.

Our study differs from the prior studies on ambidextrous leadership behaviours by focusing on the leadership versatility in decision-making behaviours, which are identified as one of the key attributes to manage ambidextrous orientation (Smith, 2014). Moreover, it is the first study to examine leadership versatility of a single individual as an enabler to IT ambidexterity. Table 1 provides a comprehensive analysis of the prior literature on ambidextrous leadership.

Authors	Definition	Key finding (s)
Gregory and Keil (2014)	Combination of bureaucratic and collaborative leadership styles	Managing IS projects require control ambidexterity (formal and informal at the same time), which is achieved through a combination of disparate (bureaucratic and collaborative) management styles.
Han et al. (2016)	Combination of transformational leadership and transactional leadership	Ambidextrous leadership positively influences on team innovation performance and its positive effects significantly stronger than single leadership.
Zhang et al. (2015)	Five dimensions: combining self-centeredness with other-centeredness; maintaining both distance and closeness; treating	The extent to which supervisors engage in holistic thinking and have integrative complexity positively relates to their paradoxical behaviour in managing people,

	subordinates uniformly, while allowing individualization; enforcing work requirements, while allowing flexibility; and maintaining decision control	which, in turn, is associated with increased proficiency, adaptivity, and proactivity among subordinates.
Rosing et al. (2011)	Combination of open and close leadership behaviour	The leaders with opening and closing behaviours and ability to switch between them deal with the ever-changing requirement of the innovation process.
Zhang et al. (2017)	Traits of humility and narcissism in combination	CEOs that are both humble and narcissistic are more likely to have socialized charisma, to cultivate an innovative culture, and to deliver innovative performance.

Table 1: Comprehensive analysis of prior research on ambidextrous leaders

2.2.2. Configurational flexibility

A recent qualitative case study (Ramesh et al., 2012) proposes that the conflicting demands between alignment and adaptability posed by agile distributed development can be addressed by a set of balanced and dual practices i.e. formal and flexible. The construct we label configurational flexibility constitutes the ability of the firm to implement a combination of formal and informal configurations, to encourage desirable behaviour by firm employees. Prior IS studies suggest the combination of formal and informal configurations may provide a better outcome than implementing any of configuration independently (Ramesh et al., 2012; Brockman and Morgan, 2003). For instance, Gulati and Puranam (2009) argue that when implemented in combination, the informal configurations may compensate for the formal

configurations by providing distinct features that formal configurations do not emphasize, and vice versa.

With a few exceptions (e.g. (Gulati and Puranam, 2009; Ramesh et al., 2012)) that examines the role of formal and informal characteristics in IS projects, the analysis of effects of configurational flexibility on IT ambidexterity is very limited. In a qualitative study of re-organisation at Cisco Systems, Gulati and Puranam (2009) show that the informal structure and formal structure will only compensate for each other when there is a powerful informal organisation already in existence, and when the gains from ambidexterity are substantial. Ramesh et al. (2012) in a multisite case study of three projects reveals that ambidexterity in agile distributed systems can be achieved by a set of balanced practices (formal structure but flexible, cohesive but distributed project teams). Our research differs in focusing on IT ambidexterity in SMEs and tests empirically how formal & informal configurations enables the exploration and exploitation of IT resource to improve project performance. Table 2 presents our comprehensive analysis of prior research on formal configuration, informal configuration and ambidexterity.

Authors	Key finding (s)
Chan (2002)	Aligning IS and business strategies improve IS performance of the firms. Organisations with Informal structures improved IS performance far more than expected, while the ones with formal structure, did not always improve IS performance.
Gulati and Puranam (2009)	The compensatory fit between formal and informal organisations is feasible under two pre-existing conditions: a powerful informal organisation and significant ambidexterity gains.

Tiwana (2010)	Combining informal with formal process-based control mechanisms can simultaneously enhance the fulfilment of project goals and develop flexibility. However, combining informal with formal outcome-based control mechanisms can instead impair these objectives.
Gibson and Birkinshaw (2004)	A combination of stretch, discipline (formal characteristics), support, and trust (informal characteristics) enable contextual organisational ambidexterity.
Gregory and Keil (2014)	Managing IS projects require control ambidexterity (formal and informal at the same time), which is achieved through disparate (bureaucratic and collaborative) management styles.
Chua et al. (2012)	The use of formal controls plays a critical role in successfully enacting informal controls, specifically clan controls.
Kirsch (2004)	IS and Business stakeholders employ a combination of formal and informal mechanisms (collaborative coordinating) to exercise control. Factors in the project, stakeholders and global contexts trigger the change between the choice of formal and informal mechanisms from one project phase to another.
Jansen et al. (2009)	The structural differentiation has a direct effect on ambidexterity and it operates through the informal senior team and formal organisational integration mechanisms.
Ramesh et al. (2012)	The conflicting demands between alignment and adaptability posed by agile distributed development can be addressed by a set of balanced practices (formal structure but flexible, cohesive but distributed project teams)

Table 2: Comprehensive analysis of prior research on formal and informal configurations

2.3. Consequences of IT ambidexterity

A handful of prior IS studies have focused either on the performance implications of IT ambidexterity in enhancing organisational agility or moderating effects of IT ambidexterity (e.g. (Lee et al., 2015; Mithas and Rust, 2016; Chi et al., 2017)). Table 3 summarizes the definition and findings of IT ambidexterity in these studies.

This research differs from prior studies by focusing on the impact of IT ambidexterity on project performance in SMEs. Mithas and Rust (2016) posit dual emphasis capability of IT resources to be a socially complex and an ambiguous resource that can enhance competitive advantage, however, the extant studies lack in elucidating whether IT ambidexterity is in fact a relevant strategy for firms to enable superior project performance. We theorize that leadership versatility and configuration flexibility may enable firms to build IT ambidexterity, which in turn may improve the firm's project performance.

Author	IT ambidexterity definition	Finding (s)
Chi et al. (2017)	Simultaneous pursuit of IT flexibility and IT standardization	IT ambidexterity is a significant moderator that can influence the choice of governance (contractual and relational) strategies of focal firms. Firms with low IT ambidexterity prefer using a balancing governance strategy rather than a complementing governance strategy, whereas, firms with high IT ambidexterity can reduce the risks of unbalancing strategy.
Mithas and Rust (2016)	Dual emphasis on IT resources in revenue	IT ambidextrous strategy strongly moderates the influence of IT investments on performance (profitability and market value) outputs, at a high

	expansion and cost reduction	level of IT investments.
Lee et al. (2015)	Simultaneous pursuit of IT exploitation and IT exploration	IT ambidexterity enhances organisational agility through the mediated effect of operational ambidexterity, and that the magnitude of this mediation depends on the levels of environmental dynamism.

Table 3: Comprehensive analysis of prior research on performance impacts of IT ambidexterity

3. Theory and hypothesis

3.1. Leadership situational theory, control theory and organisational ambidexterity theory

Leadership situational theory argues that the most effective leadership behaviour depends upon the subordinate's level of commitment and competence (maturity) (Hersey and Blanchard, 1993). This theory suggests that leaders should show relatively lower consideration and higher task structuring for employees of low-level maturity; but as the employees gain in maturity, task structuring should decrease, while considerateness should rise (Thompson and Vecchio, 2009). This study draws on leadership situational theory to conceptualize leadership versatility in adopting directive or participative leadership style and explain how leadership versatility can lead to enabling IT ambidexterity.

Control theory, initially intended to focus on the management of individual employees (Ouchi, 1979), has become one of the predominant theories in IS literature to understand the process of guiding teams members to successfully develop IT capabilities and complete IT projects (e.g. (Tiwana, 2010; Henderson and Lee, 1992; Maruping et al., 2009)). For example, Henderson and Lee (1992) examine the control behaviours in managers and team-members in an IS project. The study of Henderson and Lee (1992) reports high process

control by managers and high outcome control by team members exhibited higher performance. IS development projects often use control mechanisms to govern and fulfil project objectives (Tiwana, 2010). This study draws on control theory to theorize that firms develop formal and informal configurations to ensure employees' act according to agreed-upon strategies to achieve IT ambidexterity.

The extant literature on organisational ambidexterity theory suggests that to meet the competing demands of exploration and exploitation at the same time firms can create separate structure (structural ambidexterity, see Jansen et al. (2009)) or manage simultaneous exploration and exploitation within a subsystem (contextual ambidexterity, see Gibson and Birkinshaw (2004)). Whereas project performance may be practiced in an organisation through structural ambidexterity by separating projects that require either approach, contextual ambidexterity is required when project performance practices are needed within SMEs, owing to their resource constraints to afford separate units (Cao et al., 2009). Therefore, we use contextual ambidexterity at the firm level as the theoretical lens in our research to theorize IT ambidexterity.

3.2. Leadership versatility and IT ambidexterity

Leadership versatility in the decision-making behaviours of directive leaders and participative leaders can enable IT ambidexterity in the firms. IT ambidexterity necessitates focusing on IT exploitation and IT exploration goals simultaneously, which can create confusion and complexity in terms of target setting (Mithas and Rust, 2016). The IS literature on IT implementation projects identify the lack of clear role definitions, assigned responsibilities, expertise and clarity to result in utter confusions, stress, reduced commitment and project failures (Windeler et al., 2017; Jiang and Klein, 2000; Basu, 2015). Such situations may propel versatile leaders to adopt the directive decision-making behaviour that can reduce the inherent tension to role ambiguities. The directive decisions offer collective clarity about

roles and responsibilities by laying clear instructions and efficiently guide firm members to reach assigned milestones (Sagie et al., 2002; Kesting et al., 2015; Lorinkova et al., 2013). Directive leaders lead by means of motivation, management and monitoring of their organisational members (Druskat and Wheeler, 2003), which encourages the members to rise to the challenging goals and achieve higher efficiency outputs (Somech, 2006). Thus, it helps firms to fully utilize and leverage their existing IT resources to reap their full benefits – IT exploitation. To evade the trap of short-term benefits of exploitation in the existing market only, versatile leaders adapt to the participative style to spur exploration. For instance, successful Japanese leaders besides exploiting existing practices accommodate workers' innovative ideas and are ready to adopt and implement their suggestions for improvements (Hull et al., 1988). The participative style encourages the collection of diverse ideas through open communication and creates a common vision in collective agreements and decision-making (Sagie et al., 2002; Somech, 2006). The sense of empowerment and authority through participation in setting the organisational goals and strategies may enhance employees' commitment and involvement in creativity and exploration (Wagner and Newell, 2007). For example, the autonomy to the firm employees in decision-making resulted in the development of computer printers at HP that now accounts for almost 40% of HP's profit (Tushman and O'Reilly III, 1996). The participative decisions allow mutual discussions, ad-hoc problem-solving, discussions and information sharing, which creates a pool of diverse ideas and opinions to explore and experiment (Druskat and Wheeler, 2003; He and King, 2008). In other words, it directs attention towards technological breakthroughs, developing new technical solutions and markets – IT exploration.

In summary, the leadership versatility in adapting to both participative and directive styles develops a complementary effect where directive decisions focus on clarity, efficiency and stability required for IT exploitation, and participative decisions develop empowerment, trust,

commitment and flexibility required for IT exploration. Gregory and Keil (2014) report that IS projects are expected to advance much faster by executing only stringent policies and controls (only directive style), but on the negative side, many would be overwhelmed and there would be a lack of commitment. Whereas, leading the same project with collaborative management (participative style) only may take much longer, because you would be discussing more. Thus, it is expected that the leadership versatility in managing both directive and participative styles depending on the organisational situations can manage IT exploitation and IT exploration at the same time:

H1. The higher the leadership versatility, the higher will be IT ambidexterity.

3.3. Configurational flexibility and IT ambidexterity

IT ambidexterity is a multidimensional construct, with a fine balance of exploration and exploitation constituting separate, but interrelated and non-substitutable elements (Mithas and Rust, 2016). In other words, greater IT exploitation cannot substitute for lack of IT exploration, or vice versa. The configuration to promote exploitation contradicts with the one required to stimulate exploration (Gibson and Birkinshaw, 2004; Kang and Snell, 2009; O'Reilly and Tushman, 2008). Formal configurations such as standardized processes, structure and detailed routines that promote exploitation tend to institutionalize existing knowledge to develop the robust, reliable and efficient use of existing technologies. In contrast, informal configurations such as simple and enacted routines, structure and cultures that promote exploration provide opportunities and autonomy for individuals to absorb novel information and integrate new knowledge for innovative solutions (Kang and Snell, 2009). Adopting to a single configuration may promote one of the activities but will extenuate other. The firm configurational flexibility espouses the formal and informal configurations that can regulate and control to see both activities flourish simultaneously, because it allows formal configurations to compensate for the informal configurations by motivating distinct and

valuable forms of control that informal configurations do not emphasize, and vice versa (Gulati and Puranam, 2009). In a qualitative research of IS projects, Kirsch (2004) identifies a practice of collaborative coordinating between formal and informal mechanisms to control implementation phase. The implementation phase of IS projects considerably rely on the detailed project plans, established designs and procedures at the same time it is complemented with ad-hoc meetings and social events (Kirsch, 2004). Likewise, Chua et al. (2012) find that in the complex IT projects, the use of formal configurations essentially helps firms in successfully enacting informal configurations. In contrast, if firms rely on informal configurations only, they may fail to reap the full benefits of their explorative activity because their organisational structure may not effectively integrate with existing activities (Zahra and Nielsen, 2002). On the other hand, relying only on formal configurations may lack in exploring and experimenting new ideas (Jansen et al., 2006; Kang and Snell, 2009).

Finally, prior qualitative research identifies that the combination of formal and informal configurations support IS projects. For example, Tiwana (2010) suggests combining formal and informal mechanisms to realize both complementary as well as substitutive effects. A clarifying example is how Toyota ensures to sustain exploration and exploitation in model changeovers. Toyota implements meta-routines to formalise their production lines processes. However, they develop pilot teams for model changeovers, who suggest design modifications with minimal formal training and no instructions (Adler et al., 1999). Thus, we hypothesize the following relationship:

H2: There is a positive relationship between configurational flexibility and IT ambidexterity.

3.4. IT ambidexterity and project performance

In spite of well-known research results, and despite decades of experience of managing new projects, outcomes of technological intensive projects continue to disappoint stakeholders. Consequently, researchers and practitioner continually strive to mature

competitive IT frameworks to enhance project performance (Nambisan, 2013; Chandrasekaran et al., 2012). Project performance refers to the success of products development processes[3] to adhere to the goals of schedule, budget, quality and technical performance (Chandrasekaran et al., 2012).

IT ambidexterity can facilitate project performance. IT mechanisms can potentially enable firms to improve the consistency of project execution by enabling greater visibility of project data and by enhancing information sharing and knowledge creation (Hoang and Rothaermel, 2010). The firms that continuously utilize, reuse and leverage existing IT resources (IT exploitation) can reap the full benefits to outperform competitors in better integration of IT resources and more effective project processes. An effective integration between IT and project processes allows managers to identify and disseminate project requirements in a timely manner and facilitate agile control in project decisions (Lee et al., 2015). Repeated use of existing technologies increases the experience, streamlines product development operations and reduces transaction costs (Mithas and Rust, 2016; Benitez et al., 2017). At the same time, IT exploration can improve the project performance by acquiring, developing and assimilating better IT solutions that broaden the IT resource base for IT exploitation (Lu and Ramamurthy, 2011). In other words, IT exploration helps firm's project development processes to evade stagnation by continuously reconfiguring existing IT resources to adapt to emerging opportunities for future products and services. Therefore, IT ambidexterity ensures the long-term survival of the firms with continuous improvements in project management and project development processes. Particularly, in uncertain environments, IT ambidexterity sustains the firm position in the market by strengthening, planning and managing operational activities that allow the firm to continually sense and respond to market changes (Lee et al.,

[3] Product development processes refer to different stages in product development from idea generation to market launch (Cooper et al., 1986). Together these stages represent a project and the combined outcomes of all individual product development processes are assessed by project performance scale.

2015). For example, cell phone division in Motorola reported a loss of $394 million and laid off over 3000 employees in the third quarter of the year 2008 due to inability to develop products for existing and future cell phone requirements. The business analyst report states the decline in Motorola's market share resulted from the better product mix developed by Nokia and Research in Motion labs for current and future markets (Holmes, 2008).

Projects involve the aim of achieving IT-based competitiveness by triggering IT-enabled change within the firm. In contrast to other IT frameworks (i.e. IT investments, IT infrastructure and IT possession) in project processes that may not provide a competitive advantage due to imitability and substitutability, IT ambidexterity develops a capability that is hard for competitors to imitate. Mithas and Rust (2016) posit that firms with IT ambidexterity are likely to provide a competitive project application performance due to causal ambiguity. It may be more difficult to disentangle and attribute the advantages resulting from a complementary effect of IT exploitation and IT exploration from publicly available information because firms possessing this novel capability defy conventional logic and their initiatives and resulting competitive advantages are harder to classify or are more ambiguous to decipher for competitors.

A study by McKinsey reports that pharmaceutical companies, which stay alert towards the emerging technologies and to ensure full utilization of existing technical resources in clinical project processes, increased their overall productivity by improving the speed, quality, and costs associated with their R&D projects (Marwaha et al., 2007). We thus hypothesize the following relationship:

H3: There is a positive relationship between IT ambidexterity and project performance.

Figure 1 presents the proposed conceptual model.

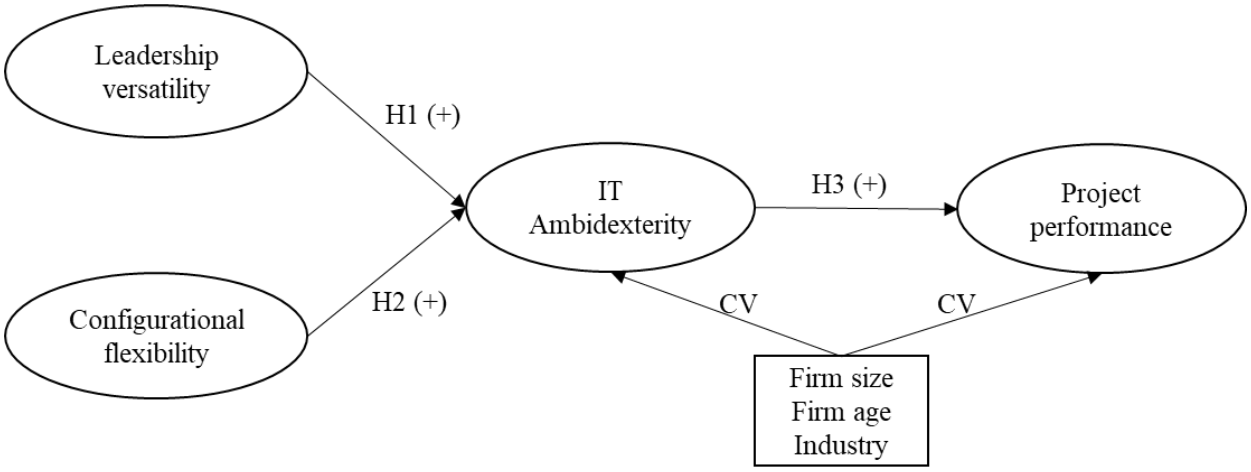

Figure 1: Conceptual model (CV = Control variable).

4. Research methodology

4.1. Sample

We empirically tested the proposed model with the sample of 1,000 UK high-tech[4] SMEs (up to 249 employees) that were randomly selected from FAME database in the year 2015. The FAME database contains descriptive information on over 270,000 major private and public limited UK companies that includes both listed and not listed firms on the London Stock Exchange. The FAME database was used in preference to others because it covers a broad variety of small, medium, and large firms in the manufacturing and non-manufacturing sectors. Moreover, the past studies of SMEs in the UK which have utilized FAME database (i.e. (Chang et al., 2011; Crick and Spence, 2005) have reported acceptable response rates.

The choice of UK high-tech SMEs as an empirical setting for this study and a critical setting to extend IT ambidexterity literature is based on several reasons. UK government has placed significant emphasis on high-tech SMEs development by introducing major initiatives e.g. The Tech City, Living Innovation (Department for Business Innovation Skills, 2011) and ranks 9th in the world in the 2009-2013 innovation index (Economist Intelligence Unit, 2009).

[4] High-tech include service or manufacturing in precision equipment, computer and electronic, control instrument, telecommunication, medical equipment and supplies, and optics apparatus, all of which are included in NAICS 2012 industry classification under codes 334, 335,51 and 54.

British government reports that SMEs account for 99.8 per cent of all enterprises in the UK and high-tech SMEs represents 65.7 percent share in overall SMEs turnover (Department for Business Innovation Skills, 2011). Moreover, bearing short product lifecycles, new projects are a continuous and an integral practice of high-tech industries for survival (Chandrasekaran et al., 2012). Finally, in particular, high-tech SMEs unlike large firms, have limited access to slack resources and immense pressures to survive, thus are compelled to pursue explore and exploit their IT resources simultaneously. In addition, literature research shows limited research of ambidexterity capability in SMEs context (Appendix A). Thus, UK high-tech SMEs represents an appealing and critical setting to better investigate our proposed hypotheses.

4.2. Data collection and screening

This study used a survey questionnaire as the data collection instrument. The survey questionnaire was developed and implemented in a manner which closely followed the recommendations of Podsakoff et al. (2003), in order to enhance the response rate and validity i.e., using established multi-dimensional scales, ensuring anonymity etc. The designed questionnaire was then presented to and discussed with senior research colleagues to remove ambiguity. After finalizing the questionnaire, the key respondents (technical leaders, operational managers and project managers) of the sample frame were contacted by a telephone call or an e-mail before sending them an email with the link of an online questionnaire.

Two reminder e-mails were sent after two weeks and four weeks of the first e-mail to the key informants who had not responded. The received responses with incomplete information and missing data values were removed from the dataset. We also truncated three respondents who seemed unengaged, as evidenced by giving the exact same response for every single item. The skewness and kurtosis test revealed that all items were normal (within the range of

+3 to -3) except for IT department size, but it was expected as our sample is focused on SMEs only. To check for any influential respondents, high leverage points, and outliers in the data set, we conducted the Cook's distance analysis of all the responses in our dataset (Chatterjee and Hadi, 1986). If any response in the Cook's distance analysis indicates a value of 0.8 or above, it is considered as an influential response. Our test revealed the maximum Cook's distance value of 0.07 indicating that there are no abnormal cases in the data. Finally, we attained 292 surveys with complete information for the variables of interest representing 29.2 percent response rate. Our final sample contains firms with a mean age of 22.58 (SD= 34.05) years and a mean size of 129 (SD=90.2) full-time employees (FTEs). The respondents had worked for 4.5 years on average in their firms and 70.4 per cent of the respondents had a doctor's, a master's or a bachelor's degree. Therefore, it is safe to assume that respondents were able to understand all the items and respond accurately. The respondent's firms are categorised into service and manufacturing firms based on the industry classification under NAICS 2012. Table 4 presents the key characteristics of our final sample.

Characteristics			**Frequency**	**Percent**
Respondent	Gender	Male	188	64.4
		Female	104	35.6
	Position	Technical managers	116	39.7
		Operational managers	73	25.0
		Project managers	103	35.3
Firm	Size	Small (up to 49 FTEs)	160	54.8
		Medium (between 50 to 249 FTEs)	132	45.2
	Type	Service	125	42.8
		Manufacturing	167	57.2

Table 4: Respondents and firm characteristics (FTEs = Full-time employees)

To detect a potential effect of non-response bias, we examined differences between the respondents and non-respondents for our final sample. The results display no pattern of differences in the sample firms and industry population minimizing concerns of non-

respondent bias. The early and late respondents *T*-tests based on demographic characteristics showed no significant differences ($p < 0.05$), indicating that non-response bias was not a problem. Follow up emails or telephone calls with the non-respondents also revealed that they did not participate either due to lack of time, or reluctance to reveal information.

4.3. Data measures

4.3.1. Leadership versatility

Leadership versatility was measured as a two-indicator composite second-order construct composed of five-indicator composite first-order construct of directive leadership and a three-indicator composite first-order construct of participative leadership. Two separate scales, developed by Sagie et al. (2002), were adopted to assess the regularity with which firm leaders display directive leadership or participative leadership styles in decision-making. Directive leadership measures the extent to which firm leaders provide team members with a framework for decision-making. Participative leadership measures the extent to which team members are involved in decision-making.

4.3.2. Configurational flexibility

Configurational flexibility was measured as a two-indicator composite second-order construct determined by three-indicator composite first-order construct of formal configuration and a four-indicator composite first-order construct of informal configurations. The measures for formal and informal configurations were adapted from the studies of Hempel et al. (2012) and Jansen et al. (2006). The formal configuration was assessed based on three items scale that measures the extent to which formalised procedures had been adopted within the organisation. Questions were asked about the use of written rule and procedures, cost controls and quality control procedures. The informal configuration was assessed by asking respondents about the degree of connectedness and informal social relation in their organisations.

4.3.3. IT ambidexterity

IT ambidexterity was operationalised as a two-indicator composite second-order construct composed of four-indicator composite first-order construct of IT exploitation and a five-indicator composite first-order construct of IT exploration. IT exploitation was measured by adapting a scale that assesses the competency of the firm to refine existing IT operation's quality, expanding existing IT services, and extending the current IT operations. IT exploration was measured by adapting a scale that captures the competency of the firm to introduce new technological applications, new informational service range, and introducing new IT practices when compared to its industry. The developed scales for IT exploitation and IT exploration were adapted from the studies of Lee et al. (2015) and Jansen et al. (2006).

4.4.4. Project performance

Project performance captures the extent to which the firm projects have accomplished the pre-set targets in the last three years. Adopting the scale developed by Chandrasekaran et al. (2012), the indicators of adherence to schedule, quality, budget, and technical performance were used to assess the project performance of the firm over the last three years. Project performance was measured as a four-indicator composite first-order construct.

4.4.5. Control variables

We used relevant control variables of firm size[5], firm age and industry on IT ambidexterity and project performance to control their possible confounding effects in this empirical study. *Firm size* was measured as the natural logarithm of the average number of FTEs (Benitez-Amado and Walczuch, 2012). *Firm age* was measured as the natural logarithm of the number of years the firm had been in business (Chen et al., 2015). A dummy variable (0: Manufacturing firm, 1: Service firm) was used to control for industry effect.

[5] In our sample, the small and medium firms differ widely with respect to the number of full-time employees as evident with high standard deviation value of firm size. Consequently, we controlled for firm size that may otherwise confound our findings.

5. Empirical analysis and results

We performed the empirical test of the proposed model using PLS path modelling, a variance-based SEM technique with the statistical software package, Advanced Analysis for Composites (ADANCO) 2.0 Professional (http://www.composite-modeling.com/). ADANCO is one of the newest developments in the field of PLS, such as consistent PLS, dominant indicators to cope with sign indeterminacy, and overall goodness-of-fit tests. It models composites, common factors, and single-indicator constructs and facilitates causal and predictive modelling (Benitez et al., 2017).

The choice of PLS in this research is appropriate, first, because we identify our constructs as composites and PLS is particularly well suited to provide consistent estimation for such models (Benitez-Amado et al., 2017; Becker et al., 2013; Henseler et al., 2014; Rigdon et al., 2014; Sarstedt et al., 2016). Second, when estimating complex models (e.g., multidimensional, second-order constructs etc.) variance-based SEM analysis provide better results than covariance-based SEM methods (Hair et al., 2012; Benitez et al., 2017). PLS SEM has been commonly used in IS research studies (Ringle et al., 2012).

5.1. Measurement model evaluation

Leadership versatility, configurational flexibility and IT ambidexterity are composite second-order constructs, whereas project performance is a composite first-order construct. We assessed the composite constructs at both first- and second-order level for multicollinearity, weights, loadings, and their level of significance.

We estimated the variance inflation factors (VIFs) to check for multicollinearity of our latent variables and indicators. All VIF values were below the cut off value of 10, ranging from 1.114 to 3.179. Thus, indicating no issue of multicollinearity among our constructs variables.

We conducted a bootstrap analysis with 4999 subsamples to check for indicators weights and loadings. The obtained results revealed that indicator weight and loadings were significant. All indicator loadings were above the minimum cut-off of 0.707, indicating that the constructs demonstrate good internal consistency and reliability (Fornell and Larcker, 1981). Appendix B provides a detailed statistical analysis for measurement items used in this study.

Leadership versatility, configurational flexibility and IT ambidexterity, multidimensional constructs, were estimated following a two-step approach (Chin, 2010). First, we correlated all first-order constructs freely to estimate the latent variable scores of the indicators. In the second step, the estimated variable scores were used as the measures for the multidimensional constructs (Leadership versatility, configurational flexibility and IT ambidexterity) (Wang et al., 2015; Benitez et al., 2017). Based on the high-correlation between the indicators for directive leadership, we used the correlation weights (mode A) instead of regression weights (model B) for directive leadership construct to enhance stability (Benitez-Amado et al., 2017). Table 5 displays the details for measurement model properties.

Construct/dimension/indicator	Mean	S.D.	VIF	Weight	Loading
Leadership versatility (composite, mode B)	3.051	2.331			
Directive leadership (composite, mode A)	3.089	1.915	1.532	0.603***	0.971***
Participative leadership (composite, mode B)	3.012	2.084	1.532	0.491***	0.763***
Configurational flexibility (composite, mode B)	3.600	2.019			
Formal configuration (composite, mode B)	3.336	1.211	1.114	0.587***	0.963***
Informal configuration (composite, mode B)	3.865	1.103	1.114	0.492**	0.797***
IT ambidexterity (composite, mode B)	3.613	2.043			
IT exploration (composite, mode B)	3.589	1.861	3.179	0.439***	0.989***
IT exploitation (composite, mode B)	3.636	1.932	3.179	0.583***	0.955***
Project performance (composite, mode B)	3.241	2.142			
Adherence to schedule	3.251	1.102	2.523	0.290**	0.829***
Adherence to budget	2.309	1.769	2.301	0.197*	0.766***

Adherence to quality	3.840	0.893	3.167	0.330^{***}	0.958^{***}
Technical performance	3.565	0.910	3.112	0.293^{**}	0.916^{***}
Firm size: Natural logarithm of the total number of full-time employees	4.162	1.851			
Firm age: Natural logarithm of the number of years of the firm's operations	1.451	0.598			
Industry: Manufacturing vs. service	2.582	1.637			

Table 5: Measurement model evaluation at first- and second-order level

Finally, the external validity of all composites was tested by performing a confirmatory composite analysis of the saturated model (Benitez-Amado et al., 2017; Henseler et al., 2014). Confirmatory composite analysis checks the adequacy of the composite models by comparing the empirical correlation matrix with the model-implied correlation matrix of the saturated model based on standardized root-mean-squared residual (SRMR), unweighted least squares (ULS) discrepancy (d_{ULS}), and geodesic discrepancy (d_G). Overall, SRMR should be lesser than 0.08 and lower values indicate better model fit (Benitez et al., 2017; Benitez-Amado et al., 2017). This analysis can detect model misspecifications that may arise due to errors in the assignment of indicators to constructs or in the number of constructs (Henseler et al., 2014). Table 6 displays our findings of confirmatory composite analysis for the first- and second-order models. The results suggest that neither model should be rejected based on an alpha level of 0.05, since all discrepancies are below the 95%-quantile of the bootstrap discrepancies. Thus, provide empirical support for the developed structure of composites at the first- and second-order levels. Altogether, the proposed model presented very good psychometric properties, implying a go ahead for a structural model assessment.

Discrepancy	**First-order level**			**Second-order level**		
	Value	HI_{95}	Conclusion	Value	HI_{95}	Conclusion
SRMR	0.063	0.372	Supported	0.043	0.285	Supported
d_{ULS}	0.705	1.610	Supported	1.716	2.972	Supported
d_G	0.535	2.450	Supported	1.371	4.530	Supported

Table 6: Confirmatory composite analysis (saturated model)

5.2. Structural model assessment

We estimated the beta coefficients and significance of the hypothesized relationships by performing a bootstrap analysis with 4999 subsamples. To test the hypothesized relationships (i.e., H1, H2 and H3), the baseline model presents all the direct effect, including all control variables. We also evaluated the effect size and R^2 values of the proposed relationships. Our results support all proposed hypothesis. Regarding first hypothesis (H1), our analysis reveals a significant positive relationship between leadership versatility and IT ambidexterity (β = 0.418, $p_{\text{one-tailed}} < 0.001$). Similarly, the results show a positive and a significant relationship between configurational flexibility and IT ambidexterity (β = 0.279, $p_{\text{one-tailed}} < 0.001$), supporting H2. Finally, as expected, IT ambidexterity has a positive and a significant influence on the project performance (β = 0.391, $p_{\text{one-tailed}} < 0.001$), consistent with H3. Table 7 displays the results of our analysis.

Beta coefficient	Baseline model	Mediation model
Leadership versatility → IT ambidexterity (H1)	0.418*** (6.795) [0.297, 0.541]	0.421*** (6.631) [0.297, 0.548]
Configurational flexibility → IT ambidexterity (H2)	0.279*** (4.637) [0.164, 0.401]	0.264*** (4.204) [0.143, 0.392]
IT ambidexterity → Project performance (H3)	0.391*** (5.972) [0.252, 0.520]	0.148*** (4.870) [0.395, 0.474]
Leadership versatility → Project performance		0.338** (3.882) [0.293, 0.581]
Configurational flexibility → Project performance		0.085 (1.060) [0.074, 0.238]
Firm size → IT ambidexterity (control variable)	0.179** (3.194) [0.063, 0.290]	0.193** (3.322) [0.076, 0.305]
Industry → IT ambidexterity (control variable)	-0.059 (-0.521) [-0.095, 0.050]	-0.032 (-0.355) [-0.054, 0.165]
Firm age → IT ambidexterity (control variable)	-0.143 (-0.0632) [-0.186, 0.082]	-0.045 (-0.666) [-0.188, 0.080]

Firm size → Project performance (control variable)	-0.084 (-1.149) [-0.0226, 0.062]		-0.095 (-1.113) [-0.268, 0.068]	
Industry → Project performance (control variable)	0.055 (0.633) [-0.072, 0.143]		0.031 (0.202) [0.047, 0.095]	
Firm age → Project performance (control variable)	-0.206 (-1.593) [-0.308, 0.031]		-0.095 (-1.113) [-0.268, 0.068]	
Endogenous variable	**R^2**	**Adjusted R^2**	**R^2**	**Adjusted R^2**
IT ambidexterity	0.544	0.531	0.539	0.528
Project performance	0.238	0.217	0.235	0.213
SRMR value	0.054		0.034	
SRMR HI_{95}	0.079		0.043	
d_{ULS} value	0.264		0.089	
d_{ULS} HI_{95}	0.583		0.147	
d_G value	0.079		0.034	
d_G HI_{95}	0.463		0.056	
f^2				
Leadership versatility → IT ambidexterity (H1)	0.233		0.230	
Configurational flexibility → IT ambidexterity (H2)	0.187		0.179	
IT ambidexterity → Project performance (H3)	0.139		0.130	
Leadership versatility → Project performance			0.122	
Configurational flexibility → Project performance			0.096	
Firm size → IT ambidexterity (control variable)	0.051		0.043	
Industry → IT ambidexterity (control variable)	0.008		0.004	
Firm age → IT ambidexterity (control variable)	0.001		0.002	
Firm size → Project performance (control variable)	0.005		0.001	
Industry → Project performance (control variable)	0.001		0.006	
Firm age → Project performance (control variable)	0.009		0.004	

Table 7: Structural model evaluation (t-values in parentheses and confidence intervals in bracket)

With an exception of firm size, the control variables did not significantly influence IT ambidexterity or project performance. The significant role of firm size for IT ambidexterity was expected because the resource munificent firms may relieve the pressures of exploration and exploitation by devoting separate resources (Raisch and Birkinshaw, 2008). Other controls of firm age and industry type may be less applicable to SMEs or it may be that there is a minimum threshold level for these factors to be significant in SMEs. Future research on IT ambidexterity should explore these relationships.

The R^2 value that explains the variance in the dependent variables were found to be 0.544 and 0.238 for IT ambidexterity and project performance respectively. The effect size (f^2) values indicate weak-to-large effect sizes between exogenous and endogenous variables (Henseler and Fassott, 2010). The effect size analysis of the relationships in our proposed model ranged from 0.001 to 0.233, as presented in Table 7.

We evaluated the goodness of fit for our structural model by confirmatory composite analysis described above. The goodness of fit measure examines the inconsistencies between the empirical correlation matrix and the model implied correlation matrix of the estimated model(s) (Henseler et al., 2014). Lower values suggest a better fit between the data and the proposed model. Overall, SRMR was 0.054 and all discrepancies were below the 95 percent quantile of the bootstrap discrepancies (Benitez-Amado et al., 2017; Henseler and Fassott, 2010), suggesting the good structural model fit between the model and data (Table 7). Table 8 shows the correlation matrix for our model variables.

Construct variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Leadership versatility	1.000						
2. Configurational flexibility	0.598***	1.000					
3. IT ambidexterity	0.610**	0.625**	1.000				
4. Project performance	0.437**	0.195***	0.316**	1.000			
5. Firm size	0.260**	0.460**	0.437**	0.006	1.000		
6. Industry	-0.089	-0.007	0.053	0.003	0.050	1.000	
7. Firm age	-0.038	0.131*	0.065	-0.110	0.369**	0.043	1.000

Table 8: Correlation matrix

5.3. Mediation analysis

We performed the mediation analysis to examine the significance of the indirect effects involved in our proposed model. This analysis estimated the indirect effects of the links between leadership versatility and project performance, and between configurational

flexibility and project performance (Table 7). The indirect effect between leadership versatility and project performance was significant at 0.10 level while the direct effect was significant at 0.05 level, which suggests partial mediation of IT ambidexterity in the impact of leadership versatility on project performance (Nitzl et al., 2016). The indirect effect between configurational flexibility and project performance was significant at 0.05 level while the direct effect was insignificant, which suggests full mediation of IT ambidexterity in the impact of configurational flexibility on project performance (Nitzl et al., 2016; Benitez et al., 2017). This model had very good fit (Table 7). Table 9 highlights the mediation results and Figure 2 presents the complete structural model findings with mediation results.

Relationship	Indirect effect	Direct effect	Total effect
Leadership versatility → Project performance (Partial Mediation)	0.162* (1.763) [-0.003, 0.134]	0.388** (3.882) [0.293, 0.581]	0.443*** (7.401) [0.362, 0.627]
Configurational flexibility → Project performance (Full Mediation)	0.139** (2.809) [0.087, 0.392]	0.085 (1.060) [0.074, 0.238]	0.261** (3.624) [0.187, 0.482]

Table 9: Mediation analysis: Indirect, direct, and total effects

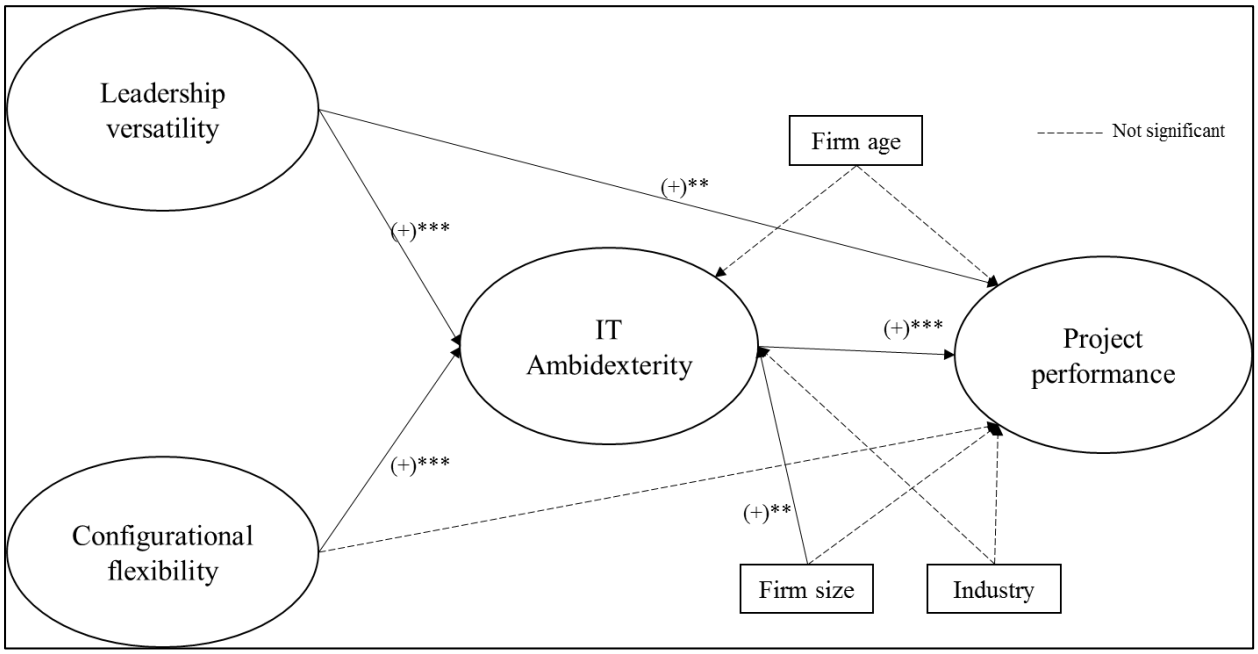

Figure 2: Structural model findings with mediation results

5.4. Common Method Bias

Although the procedural methods suggested by Podsakoff et al. (2003) were employed to control common method bias by using different scale formats and anchors for the key variables and assuring anonymity to the respondents. Common method variance might be of concern as well if the data is self-reported and obtained through one means of data collection (Lindell and Whitney, 2001). We performed Herman's one factor test (Podsakoff et al., 2003), Confirmatory factor analysis (CFA) (Fornell and Larcker, 1981; Podsakoff et al., 2003), market variable test (Lindell and Whitney, 2001) and pairwise correlation analysis (Bagozzi et al., 1991) to ensure that common method bias in not of concern.

First, we conducted Harman's one-factor test through exploratory factor analysis (EFA), where the emergence of a single factor that accounts for a large proportion of the variance suggests a common method bias (Podsakoff et al., 2003). The EFA reveals the expected four distinct factors with an eigenvalue greater than one, rather than a single factor. The four factors together account for 74.38 per cent of the total variance; the largest factor did not account for the majority of the variance (27.31 per cent). Thus, no general factor was apparent.

Second, CFA was conducted by loading all four variables on a single factor to examine the model fit. It suggests common method bias if the single factor model shows better model fit than original model (Podsakoff et al., 2003; Fornell and Larcker, 1981). The CFA revealed that the single-factor model did not fit the data well (chi-squared statistic (χ^2) (8) = 57.231, comparative fit index (CFI) = 0.812, goodness of fit index (GFI) = 0.793, Bentler-Bonett normed fit index (NFI) = 0.818, Tucker-Lewis index (TLI) = 0.725, root mean squared error approximation (RMSEA) = 0.14 and standardized root mean square residual (SRMR) = 0.09).

Third, Lindell and Whitney (2001) suggest using a theoretically unrelated marker variable to adjust correlations among the principal constructs. A high correlation among any of the study's principal constructs and the marker variable would indicate common methods bias. The marker variable tested in this study was the respondent's level of education, which revealed the lowest correlation with our key dependent variable. The addition of marker variable showed that the differences between adjusted and unadjusted correlations were minimal and did not affect the significance level of our regression results.

Fourth, the pairwise correlation matrix (Table 8) did not indicate any exceptionally correlated variables. The highest correlation among the principal constructs is 0.62, which is below Bagozzi et al. (1991) recommended 0.8 thresholds. While the results of these analyses do not preclude the possibility of common method variance completely, they do suggest that common method variance is not of great concern and thus is unlikely to confound the interpretations of our results.

6. Discussion and conclusions

6.1. Implications and key contributions to IS research

IT ambidexterity refers to the firm's ability to find the balance between experimenting with new IT resources and using existing IT resources, which has been recognized as a critical IT capability that may enhance organizational agility (Lee et al., 2015). This research examines how this IT capability can be developed in high-tech SMEs, and how the resulting tensions can be dealt with. Moreover, we test whether IT ambidexterity is a relevant strategy to enable superior project performance. The proposed theory was tested on a sample composed of 292 high-tech SMEs in the UK, and the empirical analysis suggests that IT ambidexterity is facilitated by leadership versatility and configurational flexibility. We find that the IT ambidexterity significantly enhances the project performance in the firms. The analysis also suggests that IT ambidexterity partially mediates in the impact of leadership

versatility on project performance and fully mediates the relationship between configurational flexibility and project performance. The empirical analysis thus completely supports our theory.

The key contribution of our research lies in the extension of IT ambidexterity literature. IT ambidexterity is a cutting-edge IT capability because includes the firm's balance between defining and supporting the current and future firm's business strategy. Despite of its importance, IT ambidexterity is an IT concept only proposed and investigated very recently by Lee et al. (2015), for which our understanding is extraordinarily limited in the field of IS. Given the embryonic stage of IT ambidexterity literature and lack of the studies that examine the mechanisms to facilitate firms in enabling IT ambidexterity, this study provides new evidence on how leadership versatility and configurational flexibility enables exploration and exploitation of IT resources to enhance project performance. Unlike prior research in organisational ambidexterity literature that focuses on larger firms, we focus on IT ambidexterity in high-tech SMEs. The exploitation and exploration of IT resources may be an even more critical capability for high-tech SMEs due to the intense market rivalry, limited resources, fast changing customer requirements and challenging survival.

Second, this study develops the concept of leadership versatility and configurational flexibility that can enable and resolve the tensions pertinent to complex and contradict IT capabilities such as IT ambidexterity. Although the field of IS signifies the importance of leadership role and organisational configurations in successfully implementing IS projects (e.g., (Chan, 2002; Nambisan, 2013; Gregory and Keil, 2014; Mithas and Rust, 2016)), the theory and empirical evidence to understand what leadership behaviours and which configurations can help firms to create business value is lacking. We take a step towards filling this gap by elucidating and validating that leadership versatility in adopting situation based decision-making style and configurational flexibility in allowing the combination of

formal and informal settings enhance project performances through leveraging existing and exploring new IT resources.

Finally, with the exception of few studies (Lee et al., 2015; Mithas and Rust, 2016; Chi et al., 2017), the research on the impact of IT ambidexterity is very limited. This study contributes to suggest the role of IT ambidexterity as a mediating channel that helps firm's resources to maximize the value creation in projects. This contribution has clear theoretical implications for developing a perspective on IT-enabled organisational capabilities (e.g., (Lee et al., 2015)). Moreover, in contrast to the theoretical concerns that due to resource limitations ambidexterity might become a performance constraining strategy for SMEs (Raisch and Birkinshaw, 2008). Our results demonstrate that IT ambidexterity has a strong positive influence on project performance.

6.2. Limitations and future research directions

The limitations of this study are as follows. First, our findings can be generalised to high-tech SMEs in the UK market. Further research can explore the proposed theoretical model in a sample of SMEs as well as large firms in geographically separated markets. Second, we focused on the sample composed of high-tech SMEs. Although our sample represents both service and manufacturing sectors, and we controlled for industry variables, the industry specific factors (e.g., products life cycle, market rivalry etc.) may affect the proposed theory. Third, we have not examined the environmental (munificence, complexity, uncertainty) or external factors (i.e., legal, economic or social differences) that may affect the strength of the relationships in our proposed model. Fourth, our study was survey based; it may be that a longitudinal study that would include qualitative data collection can explain how ambidexterity is realized into delivering performance. Finally, our methodology does not preclude the possibility of common method variance. However, our data analysis suggests

that common method variance is not of great concern and thus is unlikely to confound the interpretations of results.

6.3. Implications for managers

The findings of this research provide two critical lessons for IT managers. First, developing versatility in their decision-making approaches, deftly adjusted to the circumstances at hand and setting up flexible configurations to manage and monitor tasks provides the foundation to balance exploration and exploitation activities of their IT resources. The exploration and exploitation of IT resources ensure long-term survival for the firm in a rapidly changing market (Lee et al., 2015). Second, firms can differentiate themselves in the market if they can develop and leverage IT ambidexterity capability in project development processes, because, it may be more difficult to disentangle and attribute the advantages resulting from a complementary effect of IT exploitation and IT exploration from publicly available information. Thus, resulting competitive advantages are harder to classify or are more ambiguous to decipher for competitors.

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CHAPTER 3

Chapter 3 | Driving high-tech SMEs' performance through IT ambidexterity: Unveiling the influence of leadership decision-making styles

Abstract

This chapter investigates leadership (identified as a second-order construct in previous chapter) as an antecedent to IT ambidexterity in a more granular manner by focusing on individual leadership decision-making styles as first-order constructs. Further exploring how and when a particular leadership decision-making style becomes essential.

High-tech SMEs leaders are required to embed IT ambidexterity into their organisational strategy, which can be challenging. To better understand how leaders achieve IT ambidexterity, this study focuses on leadership decision-making styles (directive decision-making and participative decision-making) as key factors. Moreover, drawing on the contingency theory of leadership, we examine how and when leadership decision-making styles enhance IT ambidexterity by considering organisational diversity and shared vision as two important contingencies. Finally, we highlight the role played by IT ambidexterity in enhancing high-tech SMEs' performance. Our findings using survey data from 292 high-tech SMEs in the UK suggest that both leadership decision-making styles enable IT ambidexterity; however, the participative decision-making style is more effective in highly diverse firms, and the directive decision-making style is preferred when a shared vision is dominant among firm members. Our results also show that IT ambidexterity significantly enhances firm performance. We discuss how our findings extend management and ambidexterity research, and provide implications for practice.

Keywords: IT ambidexterity, decision-making, leadership contingency theory, organisational diversity, shared vision, high-tech SMEs

1. Introduction

The accelerating rate of technological change in high-tech SMEs rapidly replaces the established product and process technologies, thus reducing opportunities for firms to grow (Chandrasekaran et al., 2012; Hotho and Champion, 2011). To flourish or even survive in these rapidly changing environments, firms need to develop the ability to simultaneously exploit their existing technologies and explore new technological solutions (Kathuria and Konsynski, 2012; Heckmann, 2015). This capability of the firms, in the context of IT, is defined as IT ambidexterity: a simultaneous pursuit of IT exploitation and IT exploration activities within the same organisation (Lee et al., 2015; Subramani, 2004). O'Reilly and Tushman (2013) emphasise that long-term organisational survival depends upon the firm's ability to continuously refine its existing technologies and innovate new technological solutions at the same time. For example, Harris Corporation, a high-tech electronics firm, began manufacturing printing presses in order to fulfil the changing market demands (O'Reilly and Tushman, 2013). On the other hand, Motorola's cell phone division reported a decline in market shares during 2008 due to their inability to simultaneously develop products for existing and future cell phone markets (Chandrasekaran et al., 2012).

Although IT ambidexterity may enhance the firm's operational agility (Lee et al., 2015) and competitiveness (Subramani, 2004), it may continuously challenge firm leaders to make decisions in order to manage the contradicting and paradoxical demands that are inherent to exploitation and exploration activities (Jansen et al., 2008; Carmeli and Halevi, 2009) because the routines, structures, processes and skills required for exploitation are fundamentally different from those required for exploration (O'Reilly and Tushman, 2008). Thus, firm leaders are frequently required to make clear and consistent decisions to allocate resources and provide guidance to leverage both strategies simultaneously (Smith, 2014; Raisch and Birkinshaw, 2008), which can help firms to avoid falling into a failure trap

(excessive exploration at the expense of exploitation), or a success trap (excessive exploitation at the expense of exploration) (Wang et al., 2015). In particular with regard to high-tech SMEs where firms have limited scarce resources available and market demands change rapidly (Hotho and Champion, 2011), the significance of the leadership decision-making style becomes evident as a critical tool to successfully address the contradicting needs of these strategic activities (Smith, 2014). The leadership decision-making style characterises the approach that the firm leader takes in reaching a decision (Chandrasekaran et al., 2012). How different decision-making styles might influence high-tech SMEs' leaders to enable IT ambidexterity still remains relatively unexplored.

The decisions taken to develop IT constructs are done with the intention to benefit. However, due to misalignment between the leadership decision-making style and organisational values and norms, IT development decisions may not fully realise the expected benefits (Martinsons, 1991). In other words, the effect of leadership decision-making styles on IT strategies may be contingent upon organisational factors. Raisch and Birkinshaw (2008) highlight the need to examine the role of contingencies that may influence the effectiveness of organisational leaders in developing ambidextrous organisations. While previous studies have shown the influence of external environments within this context, the role of internal factors remains less explored (Mihalache et al., 2014). Therefore, we use the contingency theory to examine the moderating effect of internal organisational factors – organisational diversity and shared a vision – on the relationship between leadership decision-making styles and IT ambidexterity in high-tech SMEs. Organisational diversity refers to the extent to which organisations value and tolerate difference in viewpoints, skills, knowledge, and information (Wang and Rafiq, 2009). Shared vision refers to the collective goals and aspirations of firm members that sets a common strategic direction that ameliorates conflicts and disagreements (Tsai and Ghoshal, 1998). The choice of organisational diversity and shared vision as the organisational factors is

based on several reasons. First, in contrast to other dimensions of organisational contexts that represent processes and systems of firms, i.e. discipline, stretch and support (Gibson and Birkinshaw, 2004), organisational diversity and shared vision represent firm values and norms (Wang and Rafiq, 2014). Second, scholars argue that the attributes of diversity and shared vision may directly influence the outcomes of leadership decisions (Mihalache et al., 2014; Jansen et al., 2008). Consequently, it becomes important to include the potential ramifications of these factors on the effectiveness of leadership decision-making styles. Third, Wang and Rafiq (2014), in a comparative study of UK and Chinese high-tech SMEs, show that organisational diversity and shared vision create an organisational culture that allows these firms to foster ambidexterity. Their finding supports the argument that high-tech SMEs involve people with diverse skillsets to achieve a common goal (Akgün et al., 2004). Thus, how these factors may influence the strength of decision outcomes play a key role in the context of this study. Finally, despite the emphasised significance of organisational diversity, shared vision and leadership decision-making styles in the literature of organisational ambidexterity, empirical studies to examine the influence of these factors seem to be neglected. Thus, this study examines two key critical questions:

Q1: How might different decision-making styles influence high-tech SMEs' leaders to enable IT ambidexterity?

Q2: How does organisational diversity and shared vision influence the strength of the relationship between leadership decision-making styles and IT ambidexterity?

To answer these questions, we use a survey methodology to collect data from 292 high-tech SMEs in the United Kingdom (UK). The collected data is then analysed using Structural Equation Modelling (SEM).

This study contributes to management literature in a number of ways. First, our findings highlight the role of different leadership decision-making styles in influencing firm employees to enable IT ambidexterity. Second, we apply the contingency theory to understand when and how leadership decision-making styles might be most or least effective, by examining the moderating role of organisational diversity and shared the vision. Third, this study contributes by highlighting the effectiveness of IT ambidexterity in achieving organisational performance in high-tech SMEs. Finally, our findings offer practical and methodological implications for both theory and practice.

The rest of the paper is organised as follows. The next section discusses the significance of IT ambidexterity and expands our theory by discussing the link between leadership decision-making styles and IT ambidexterity. We then develop our research model and hypothesis in section three. The research methodology is discussed in section four. Section five presents our data analysis and results, followed by discussion, research implications, limitations and future research avenues and conclusion in section six.

2. Background

2.1 Leadership decision-making styles

Researchers and practitioners have been debating the attributes of leadership that influence the development of the ambidextrous strategy (O'Reilly and Tushman, 2013). Some of these attributes are: social integration among top managers (Jansen et al., 2008), decision-making authority (Mom et al., 2009), behavioural integration (Lubatkin et al., 2006), and top management demographics (Escribá-Esteve et al., 2009). However, despite the contribution of previous studies (Smith, 2014; Crick and Spence, 2005; Costanzo and Di Domenico, 2015), few studies have expanded their scope to examine leadership decision-making style as a driver of achieving ambidexterity. A leadership-decision making style has been argued to

be a significant managerial tool to initiate exploration and exploitation at the same time (Smith, 2014) and manage complex tasks, for example, venture capitals (Costanzo and Di Domenico, 2015).

This study attempts to fulfil this gap by examining the decision-making styles of organisational leaders that are identified by Vroom and Yetton (1973) seminal work on organisational decision making regimes —directive decision-making and participative decision-making. The leadership directive decision-making (DDM) style is expected to provide team members with a framework for decision-making and action in alignment with the superior's vision; whereas the leadership participative decision-making (PDM) style expects leaders to make joint decisions with their employees (Sagie et al., 2002). A recent review by Van Lange et al. (2014) on social dilemmas suggests leadership DDM and PDM styles as the two basic decision-making regimes that leaders tend to adopt to manage contradictory activities. We focus on these two leadership styles for several reasons. First, leadership DDM and PDM styles are two well-vetted, foundational models of leadership decision-making styles (Martin et al., 2013) that can form the basis for examining more complex leadership styles e.g. the transformational leadership style. Second, both leadership DDM and PDM styles have been associated with higher performance outputs (Sagie et al., 2002; Martin et al., 2013). The leadership DDM style is commonly associated with establishing task proficiency and exploitation, while the leadership PDM style is associated with spurring creativity and exploration (Martin et al., 2013). Finally, Sims et al. (2009), upon their findings of a trauma centre, argue that leadership DDM and PDM styles represent the two dominant and omnipresent leadership decision-making styles. Therefore, we examine the role of DDM and PDM styles in assisting leaders to resolve the conflicts, tensions and ambiguities that occur when enabling IT ambidexterity.

2.2 Contingency theory of leadership

The contingency theory of leadership suggests that no single model of leadership is appropriate for all employees in all organisations or contexts; rather, it depends upon the situational factors that are key to the given situation (Sims et al., 2009). There is a paucity of studies analysing the important contingencies in understanding the effectiveness of organisational leaders in developing ambidextrous organisations (Raisch and Birkinshaw, 2008). In an attempt to fulfil this research gap, this study measures the contingent effects of organisational diversity and shared a vision on the relationship between the leadership-decision making style and IT ambidexterity. Organisational diversity and shared vision have been argued to be key organisational factors in enabling ambidexterity (Wang and Rafiq, 2009; Wang and Rafiq, 2014). By doing this research, our study contributes to the understanding of when and how leadership DDM and PDM styles might be most or least effective.

2.3 Significance of IT ambidexterity

Advances in the strategic management of IT resources have recognised IT ambidexterity as a source of organisational agility and performance (Morabito, 2016; Lee et al., 2015). IT ambidexterity represents the ability of the firm to undertake IT exploitation and IT exploration at the same time (Lee et al., 2015; Subramani, 2004). IT exploitation is associated with continuous refinement, and extending skills and capabilities of existing technological resources, whereas IT exploration refers to searching and experimenting, and the innovation of new technological practices and solutions that firms do not possess (Lee et al., 2015).

Some of the nascent work in IS literature has begun to discuss the implications of IT ambidexterity on performance outputs. For example, Gregory et al. (2015) highlight the implications in IT transformation programs; Heckmann (2015) in business process management; and Morabito (2016) in user adaptation to IT-related organisational changes.

However, the empirical studies to measure the performance impacts of IT ambidexterity are few, i.e. Lee et al. (2015), Mithas and Rust (2016) and Leidner et al. (2011). Lee and colleagues found a positive impact of IT ambidexterity on organisational agility through a mediated effect of operational ambidexterity (Lee et al., 2015). Their study only highlights the assistive role of IT ambidexterity, and not the direct effect on performance measures. The second empirical study by Mithas and Rust highlight the role played by IT dual strategy (cost reduction and revenue expansion) and IT investments in influencing profitability and firm market value (Mithas and Rust, 2016). Their study uses secondary sources for data collection. Finally, Leidner and colleagues highlight the superior performance of IS ambidextrous strategy in their post-hoc analysis (Leidner et al., 2011), however, with only a limited number of ambidextrous firms to analyse. Thus, our empirical study seeks to contribute to IT ambidexterity literature by removing these shortcomings. In doing so, we respond to the endorsement of scholars to examine the direct impact of IT ambidexterity on organisational performance (Iyengar, 2007; Mithas and Rust, 2016) by using primary data.

3. Research model and hypotheses

Drawing on the contingency theory of leadership, this study proposes that the effect of the leadership decision-making style on IT ambidexterity may depend upon organisational factors. The research model in Figure 1 highlights the moderating role of organisational diversity and shared vision on the relationship between decision-making styles and IT ambidexterity.

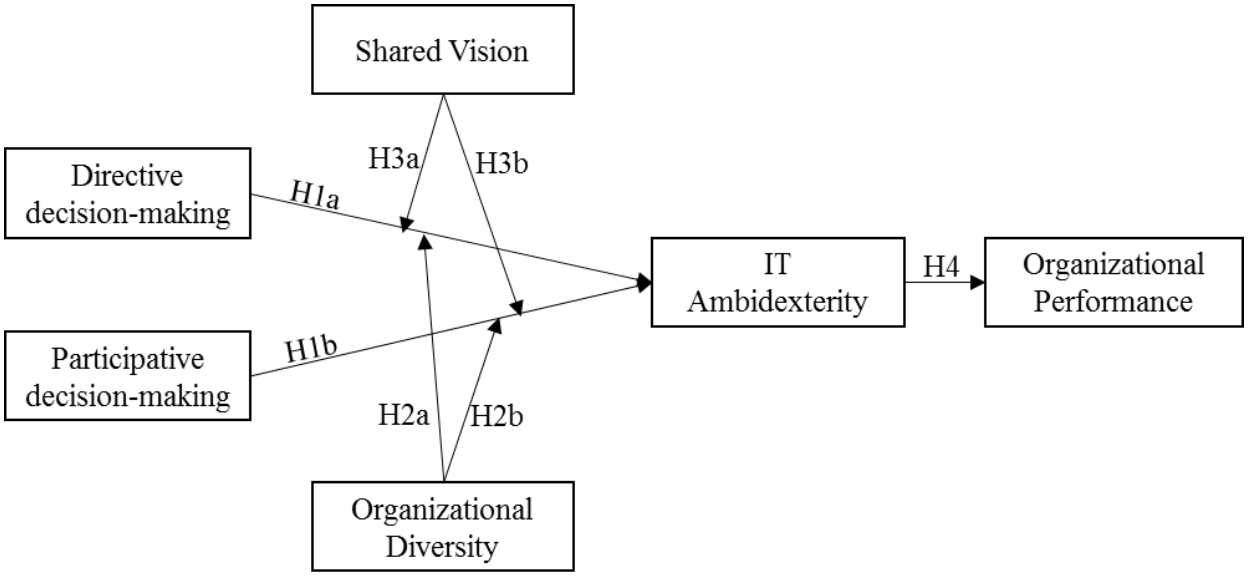

Figure 1: Research model

3.1 Leadership decision-making styles and IT ambidexterity

Leadership decision-making styles are argued to have resolved the paradoxical tensions that may arise due to the simultaneous pursuit of two differing activities (Smith, 2014). Building on this premise, this study evaluates the role of leadership DDM and PDM styles in enabling IT ambidexterity. The leadership DDM style initiates straight-forward decision-making that aims to guide followers' participation by structuring clear instructions for problem solving (Martinsons and Davison, 2007). The leadership PDM style is referred to as joint decision-making, or at least shared influence in decision making, by supervisors and their subordinates (Locke and Schweiger, 1979).

The defined roles, responsibilities, and clear directions created by the leadership DDM style may help to reduce ambiguities such as resource allocation, goal setting, etc., while pursuing IT exploitation and IT exploration at the same time. However, previous studies, e.g. (Kesting et al., 2015; Somech, 2006) suggest that the leadership DDM style leads to a commonality of purpose among employees and does not support creativity. Thus, the leadership DDM style tends to develop social control mechanisms that can stifle attempts for radical thinking and

ideas (Somech, 2006) as it restricts communication and dampens the possibility of a leader drawing on lower-level expertise. On the other hand, the sense of empowerment and authority that is created through the leadership PDM style tends to increase employee commitment and involvement in creativity and innovation activities (He and King, 2008), fostering IT exploration. Continuous feedback and information flows through mutual discussions and incorporates diverse knowledge that broadens firm members' perspectives and enhances their work efficiency (Jensen et al., 2011), thus supporting IT exploitation activities.

The leadership DDM style encompasses the centralisation of decision-making. The information goes through a lengthy filtering process as it travels up the hierarchy to reach decision makers, resulting in information that could be of low quality or biased (Mihalache et al., 2014). This implies that the leadership DDM style might not support IT exploration activities that require continuous search and the generation of ideas, specifically in high-tech SMEs where process and product technologies can change rapidly (Chandrasekaran et al., 2012). Conversely, broader participation in the leadership PDM style tends to increase the diverse set of viewpoints and perspectives considered in decision-making, that may result in better decisions (Mihalache et al., 2014). It may also allow the implementation of new ideas with greater efficiency, particularly if the persons implementing the policy have participated in developing that policy (Jensen et al., 2011; He and King, 2008). Jensen et al. (2011) suggest that the leadership PDM style allows employee participation in mutual discussions, ad-hoc problem solving and information sharing, which creates a pool of diverse ideas and knowledge. Organisational members can use this knowledge pool to simultaneously refine their existing practices and to discover new opportunities.

Finally, the leadership DDM style has the inherent ability to specify tasks and restrict employee focus, which helps to implement operational objectives in a systematic and

efficient way (Connor and Becker, 2003). Such focus might only help to improve the effectiveness of existing IT resources, thus, supporting IT exploitation. However, IT ambidexterity demands a simultaneous pursuit of IT exploitation and IT exploration activities; therefore, we hypothesise that the leadership DDM style may not enable IT ambidexterity. Raes et al. (2011) suggest that top managers and middle managers need to collectively make sense of complex and ambiguous information, and mutually influence each other to make decisions and conduct activities that seem opposing to each other in terms of mind-set and allocation of resources. The leadership PDM style can stimulate the simultaneous pursuit of exploration and exploitation activities by encouraging comprehensiveness in the strategic decision-making process (Mihalache et al., 2014). Therefore, we hypothesise:

> ***H1a, b**: Whereas directive decision-making does not enable IT ambidexterity, participative decision-making will lead to enhanced IT ambidexterity.*

3.2 Moderating role of organisational diversity

In this research, organisational diversity refers to the extent to which organisations value and tolerate differences in viewpoints, skills, knowledge and information (Wang and Rafiq, 2009). The differences in view-points, opinions and skills can help to create a valuable and broader informational and knowledge resource (Somech, 2006). Previous research shows that organisational diversity can enhance judgment, problem-solving, and decision-making capabilities through team-level processing of unique skill sets, information, and healthy task-related conflicts (Van Knippenberg and Schippers, 2007). Depending upon the characteristics of the task, it may also have detrimental effects on group functioning due to emotional conflict, e.g. higher levels of organisational diversity may create social divisions, resulting in poor social integration and negative outcomes (Mannix and Neale, 2005).

The leadership DDM style tends to provide followers with clear guidance and requires them to follow the instructions precisely (Martinsons and Davison, 2007). The leadership DDM style induces hierarchy, and leaders may not be able to resolve the potential negative impacts of organisational diversity, i.e. conflict and social integration that may result in a lack of motivation and interest among employees (Drach-Zahavy and Somech, 2001). Additionally, leaders may not be able to identify, extract and combine the knowledge of potential advisors from various areas of expertise (Mannix and Neale, 2005). Enabling IT ambidexterity can be challenging in that it requires tough decision-making and can only be successfully implemented with strong cohesion among firm members (Wang and Rafiq, 2009). Therefore, high levels of organisational diversity might tend to decrease the influence of the leadership DDM style in enabling IT ambidexterity. On the other hand, the leadership PDM style necessitates discussion, consultation, and involvement of firm members in decision making processes, resolving the potential negative effects of diversity (Drach-Zahavy and Somech, 2001). The leadership PDM style can view and consider factors that had not previously been considered by exploiting the patterns of heterogeneity in thoughts, skills, and information from employees (Somech, 2006). Therefore, the high level of organisational diversity among team members can benefit the leadership PDM style to create an atmosphere where ambidextrous tasks can be discussed, questioned and reflected on, based on the knowledge of a diverse set of advisors and resulting in better decision-making (Drach-Zahavy and Somech, 2001). Hence, we hypothesise:

> ***H2a, b****: High levels of organisational diversity negatively (positively) moderate the relationship between DDM (PDM) and IT ambidexterity.*

3.3 Moderating role of shared vision

Shared vision refers to the collective goals and aspirations of firm members that set a common strategic direction, ameliorating conflicts and disagreements (Tsai and Ghoshal, 1998). Shared vision channels the focus of firm members towards a common direction, sets a sense of purpose, and promotes integration among them (Sinkula et al., 1997). In other words, shared vision encourages collective behaviour by translating diverse ideas into focused actions (Wang and Rafiq, 2014).

Firm members with a high level of shared vision can foster the decision directives with active involvement and higher motivation, as it reinforces their own strategic intentions (Jansen et al., 2008). A shared vision can help in the effective implementation of complex decisions that require employee effort and commitment (Tsai and Ghoshal, 1998; Jansen et al., 2008), i.e. the simultaneous pursuit of IT exploitation and IT exploration whilst limited resources are available for deployment. Wang and Rafiq (2009) characterise a firm without shared vision as a group of highly committed employees who are pulling the organisation in different directions. A shared vision can help to channel commitment towards common objectives, thus boosting the firm's ability to implement organisational decisions (Wang and Rafiq, 2009). Shared vision could be one of the internal processes discussed by Mihalache et al. (2014). They argue that ambidexterity depends upon the top management team's internal processes that enable them to handle large amounts of information and alternatives decision, and to deal with conflict and ambiguity. Based on the aforementioned arguments, we expect shared vision to assist leaders in decision-making and the effective implementation of decisions, irrespective of decision-making styles. Hence, we hypothesise:

> ***H3a, b****: High levels of shared vision positively moderates the relationship between DDM (PDM) and IT ambidexterity.*

3.4 IT ambidexterity and organisational performance

IT plays a critical role in influencing a firm's overall performance (Kathuria and Konsynski, 2012). However, multiple performance dimensions exist when examining firm performance. Based on previous research, e.g. (Morgan and Berthon, 2008; Jaworski and Kohli, 1993) that involves both financial and business performances to assess organisational performance, this study evaluates organisational performance with the firm's competitive position, sales growth, average profit per customer, and return on investment.

IT exploration activities help organisations to discover significant and radical new technologies, while IT exploitation allows the firm to further refine the existing technologies (Lee et al., 2015). IT ambidexterity allows firms to enhance the efficiency of existing technological resources and compete in existing markets, and at the same time create new IT solutions and breakthroughs to sustain competitive positions in future markets (Morabito, 2016). This is in particular with regard to high-tech SMEs, where market turbulence and competitive intensity are considered to be common market characteristics of high-tech environments (Tsai et al., 2013). Under such conditions, some of the key technologies might become obsolete (Kathuria and Konsynski, 2012). Thus, to survive in a high-tech industry, the simultaneous approach in IT exploitation and IT exploration becomes particularly essential, not only for the upgradation of existing IT resources, but also for the integration and adjustments of new technological breakthroughs (Morabito, 2016). IT ambidexterity has a tendency to enhance the effectiveness of operational initiatives to make firms more agile in dynamic business environments (Lee et al., 2015). Based on aforementioned arguments, we expect IT ambidexterity to improve competitive positions by spurring technological breakthroughs. At the same time, the effective use of existing technology may enhance average profit per customer, returns on investment, and overall organisational performance. Hence, we hypothesise:

***H4**: IT ambidexterity positively impacts organisational performance.*

4. Methodology

4.1 Empirical context and data collection

A sample of one thousand high-tech SMEs was drawn from the FAME database of registered UK firms. The firms were selected via the utilisation of a systematic random selection procedure, based on a variety of criteria including date of registration, number of employees, and high technological specialities.

High-tech SMEs should be an important context of study for management researchers for several reasons. First, due to technological changes and survival stress, high-tech SMEs need to react rapidly, develop mechanisms to quickly assess opportunities and allocate resources to benefit from them (Crick and Spence, 2005). Such uncertain and demanding environments may provide an important setting to test the influence of management strategies. Second, this sector of SMEs are expected to employ approximately 40 per cent of high proficiency workers, including computer workers, scientists and engineers (Bharati and Chaudhury, 2015). Third, high-tech SMEs inherently operate in a dynamic environment where the role of management strategies for innovation, growth and survival becomes critical (Parida et al., 2012). Thus, the role played by leadership in making strong decisions becomes a key attribute in high performing high-tech SMEs (Crick and Spence, 2005). Fourth, studies suggest that technological-intensive firm leaders are often confronted with the pressures to explore new technological practices due to frequent changes in customer demands, technologies and competition. At the same time, they face pressures to exploit existing technologies, due to short-term competitive pressures that requires an increased focus on efficiency (Chandrasekaran et al., 2012; Wang and Rafiq, 2014). Finally, owing to low structural and operational complexity in SMEs (Crick and Spence, 2005), the impact of IT exploitation

activities, IT exploration activities, decisions and management strategies may be assessed more precisely. The aforementioned characteristics of high-tech SMEs may provide an appealing context to examine the influence of leadership decision-making styles in enabling IT ambidexterity. The UK is an appropriate empirical setting for this study because the UK government has started larger scale initiatives called "living innovation" in an attempt to encourage growth in SMEs (Oke et al., 2007). Additionally, the UK government claims that SMEs account for at least 99 per cent of the businesses in every main industry sector and incorporate 60 per cent of overall employment in the UK (Department of Culture Media & Support, 2015).

We use the survey methodology for data collection. In an effort to improve content validity and response rates, the online questionnaire was designed, formulated, and implemented in a manner which closely followed the recommendations of a variety of authors, i.e. (Podsakoff et al., 2003). In order to limit the potential measurement errors, responses were collected from key informants knowledgeable in a variety of strategic activities (Nayyar, 1992). Thus the key informants chosen were IT directors/managers with the authority to make decisions. The key informants were contacted by telephone or email and the link to the online questionnaire was then emailed to all the respondents who agreed to participate in the study.

After two follow-up reminders, the received responses were screened to remove any responses that were ineligible due to incomplete information, had missing data values, or seemed disengaged – selecting one option for all answers or completing survey in less than 3 minutes. After data screening, 292 valid responses (29.2 percent response rate) were obtained. The key informants had worked for an average of 4.5 years in their firms. Table 1 shows the characteristics of key informants and responding firms.

Key informant's education	**Frequency**	**Percent**
high school degree or equivalent	93	29.6
Bachelor degree and above	199	70.4
Key informant's tenure with respective firms		
less than 5 years	38	14.3
between 5 to 10 years	159	53.2
more than 10 years	95	32.5
Firm size		
Small (up to 49 employees)	160	54.8
Medium (50-249)	132	45.2
Firm age		
Less than 5 years	55	18.8
between 5 - 10 years	51	17.5
between 10 - 15 years	84	28.8
more than 15 years	102	34.9
Firm Type		
Service	125	42.8
Manufacturing	167	57.2

Table 1: Characteristics of key informants and firms

To test for non-response bias, we examined differences between respondents and non-respondents for our final sample. T-tests showed no significant differences based on the number of full-time employees, industry sector (service versus manufacturing), firm age and prior performance. We also compared early and late respondents in terms of control and model variables. These comparisons did not reveal any significant differences ($p < 0.05$) between the two groups, indicating that non-response bias was not a problem in this study.

Variables	Operational definitions and measures
IT ambidexterity	IT ambidexterity represents the simultaneous approach of firms in pursing IT exploitation and IT exploration activities (Lee et al., 2015). Following prior studies e.g. (Edwards, 1994; Lubatkin et al., 2006), IT ambidexterity was measured by taking the additive interaction of IT exploration and IT exploitation measures. IT exploitation assesses the ability of the firm to refine existing IT operation's quality, expanding existing IT services, and extending the current IT operations. This was measured by adapting a four items scale ($\alpha = 0.89$) from the studies of Jansen et al. (2006) and Lee et al. (2015). IT exploration is the ability of the firm to introduce new technology applications, new informational service range, and introducing new IT practices when compared to its industry. This was measured by adapting a six items scale ($\alpha = 0.94$) also from the studies of Jansen et al. (2006) and Lee et al. (2015).
Directive decision-making	The extent to which firm leader provides team members with a framework for decision-making and action in alignment with the superior's vision. The six item scale ($\alpha = 0.94$) was adopted from Sagie et al. (2002).
Participative decision-making	The extent of involvement by team members with organisational leaders in making decisions related to problem solving, initiating changes, or setting goals and tasks of the firm. The three items ($\alpha = 0.89$) scale was adopted from Sagie et al. (2002).
Organisational diversity	The extent to which difference in viewpoints is tolerated in the firm. The three items scale was adopted by Wang and Rafiq (2014). After conducting a reliability analysis, we excluded one item of the scale that had relatively low loading resulting in a two items scale ($\alpha = 0.81$) for organisational diversity.
Shared vision	The extent to which organisational members have collective goals and shared aspirations. The four items scale was adopted from Sinkula et al. (1997) and Tsai and Ghoshal (1998). After conducting a reliability analysis, one item was excluded from the scale that had relatively low loading resulting in three items ($\alpha = 0.88$) scale for shared vision.
Organisational Performance	Organisational performance was operationalised by assessing firms' relative position in comparison to their close competitors in terms of competitive position, sales growth, average profit per customer, and return on investment. Adopting the five items scale ($\alpha = 0.92$) from Morgan and Berthon (2008), the respondents were asked to compare their organisational performance with close competitor firms over the span of last three years.

Table 2: Construct variable's adopted measures and definitions

4.2 Measurement and validation of constructs

All the measures in the study were adopted from the well-established scales in literature. Every attempt was made to use existing validated measures that have good psychometric properties, although we made some modifications to suit the context of our research. Table 2 displays the definitions and the source of measures adopted.

4.3 Common method bias

To examine common method bias (issues associated with a single means of data collection) we conducted Herman's one-factor test and confirmatory factor analysis for all construct variables consistent with the recommendations of Podsakoff et al. (2003). Exploratory factor analysis with combined items from dependent variables, independent variables, and moderating variables revealed initial evidence that no common method bias was present in our data. This was demonstrated by the presence of no single factor that accounted for more than half of the total variance explained, which was further confirmed by scree plots. Further evidence of this was obtained using confirmatory factor analysis in which a one-factor, a two-factor, and a three-factor model structure were compared to our measurement model, with the single-factor model producing the poorest fit (χ^2/df=9.76, p<0.001; CFI=0.80; GFI=0.78; RMSEA=0.13; SRMR=0.12). Our hypothesised model clearly outperformed other configurations in terms of discriminant validity, as evidenced by significant chi-square reductions (χ^2/df =2.60, p<0.001; CFI=0.93; GFI=0.87; RMSEA=0.07; SRMR=0.03). Table 3 presents the statistics of measuring items. While the results of these analyses do not preclude the possibility of common method variance completely, they do suggest that common method variance is not of great concern and thus is unlikely to confound the interpretations of our results.

IT Exploitation (CA[6]=0.89, CR[7]=0.92, AVE[8]=0.68)	**Factor loadings**
Our firm frequently refines the existing level of IT components, such as hardware and network resources.	0.80
Our firm reuse existing IT skills.	0.73
Our firm improves existing IT applications and services.	0.74
Our firm continually expands existing IT services for existing clients.	0.81
IT Exploration (CA=0.94, CR=0.95, AVE=0.66)	
Our firm pursues innovative applications of IT.	0.83
Our firm experiments and develops unique IT applications.	0.84
We frequently utilize new opportunities through new IT services.	0.87
Our firm accepts demands that go beyond existing level of information services.	0.86
Our firm regularly searches for and acquires new IT resources (e.g., new generation of IT architecture, potential IT applications, and critical IT skills).	0.87
Our firm experiments with new IT management practices.	0.87
Directive Decision-Making (CA=0.94, CR=0.94, AVE=0.71)	
Our firm leader is an exciting public speaker.	0.77
Our firm leader provides inspiring strategic and organisational goals.	0.90
Our firm leader appears to be a skilful performer when presenting to a group.	0.84
Our firm leader is inspirational, able to motivate by articulating effectively the importance of the task.	0.90
Our firm leader consistently generates new ideas for the future of the organisation.	0.83
Our firm leader has a vision, often brings up ideas about possibilities for the future.	0.82

[6] Cronbach's Alpha
[7] Composite Reliability
[8] Average Variance Explained

Participative Decision-Making (CA=0.89, CR=0.89, AVE=0.73)	
We are fully involved with our leadership in solving problems in our firm.	0.84
We are fully involved with our leadership in initiating changes in your department.	0.90
We are fully involved with our leadership in determining the goals and tasks of our subordinates	0.82
Organisational Diversity (CA=0.81, CR=0.81, AVE=0.69)	
We respect everyone's different viewpoints.	0.89
We value people from diverse backgrounds with diverse experiences and skills.	0.78
Shared Vision (CA=0.88, CR=0.88, AVE=0.71)	
The future direction of this business unit is clearly communicated to everyone.	0.87
There is a strong sense of where this business unit is going.	0.85
Everyone who works here is well aware of the long-term plans and direction of this business unit.	0.81
Organisational Performance (CA=0.92, CR=0.91, AVE=0.69)	
Competitive position	0.78
Sales growth	0.85
Average profit per customer	0.85
Return on investment	0.82
Overall firm performance	0.84

Table 3: Statistics of measuring items

4.4 Control variables

We included the control variables in the form of organisational characteristics to control for their potential confounding impact on both moderating and dependent variables. The

organisation's resource endowment has been identified as a contingency factor for both the performance effects as well as ambidexterity itself (Jansen et al., 2006). Firm size and IT department size are included as control variables because resource-munificent corporations are less restricted by the challenge of resources allocation between exploration and exploitation activities (Lubatkin et al., 2006). Firm size is measured by taking the natural logarithm of the number of full-time employees in the firm and IT department size as the natural logarithm of the number of full-time employees in the IT department. Some scholars argue that younger firms might be in a better position to balance exploration and exploitation activities because they have not been subjected to core rigidities and competency traps, while others suggest that younger firms may have a limited endowment of resources, which may be inadequate to balance between exploration and exploitation (Venkatraman et al., 2007). Therefore, we also include Firm age and IT department age as control variables. Firm age represents the natural logarithm of the number of years the firm has been in business and the IT department age as the natural logarithm of the number of years the IT department had been in place.

5. Analysis and results

5.1 Validity check

We first assessed the convergent and discriminant validity of our constructs. Table 3 shows that all the item loadings are above the minimum cut-off of 0.70, indicating a good convergent validity of each construct. The Cronbach's alpha (CA) values and composite reliability (CR) values are all greater than the minimum cut-off value of 0.70. This indicates that all the constructs demonstrate good internal consistency and reliability (Peterson and Kim, 2013). Discriminant validity is additionally tested using the average variance extracted (AVE). All the diagonal values shown in Table 4 are the square root of AVE. They are higher

than the correlation values of the construct with other latent variables, which indicates the evidence of discriminant validity among the multi-indicator construct (Barclay et al., 1995).

Table 4 presents the means, standard deviations, and correlations of the construct variables. To examine the issue of multicollinearity, we calculated variation inflation factors (VIF) which indicated no problems of multicollinearity as all values were below the cut-off value of 3 (Thatcher and Perrewe, 2002). The scree plots indicated no concerns regarding outliers or influential data responses that may affect regression results.

We performed the maximum likelihood structural equation modelling (SEM) analysis to test our hypothesis. SEM seemed an appropriate analysis approach because it reduces the biasing effects of random measurement errors and allows estimation of multiple associations of the variables through simultaneously incorporating observed and latent constructs in the model (Shook et al., 2004). We performed an alternative hierarchical regression analysis using Stata IC; the results of this additional analysis replicated the same findings for all hypotheses. The model fit of the CFA model was first achieved to assess the fit of the overall measurement model (χ^2/df=3.85, p<0.001; CFI=0.98; GFI=0.98; RMSEA=0.09; SRMR=0.03) before examining the psychometric properties of our construct. The threshold criteria for a good model fit should meet following criteria; χ^2/df < 3, CFI > 0.80; GFI > 0.95; RMSEA<0.05, and SRMR<0.09 (Hu and Bentler, 1999).

Variables		Mean (SD)	1	2	3	4	5	6	7	8	9	10
1	IT ambidexterity	7.17 (1.98)	**0.83**									
2	Directive decision-making	3.73 (1.01)	0.59	**0.84**								
3	Participative decision-making	4.10 (0.84)	0.44	0.57	**0.85**							
4	Organisational diversity	4.35 (0.75)	0.31	0.41	0.43	**0.83**						
5	Shared vision	4.03 (0.88)	0.37	0.49	0.54	0.53	**0.84**					
6	Organisational performance	3.60 (0.81)	0.46	0.44	0.35	0.28	0.35	**0.83**				
7	Ln Firm size	4.13 (1.02)	0.43	0.26	0.1	0.14	0.1	0.28	_			
8	Ln IT size	1.89 (1.67)	0.23	0.19	0.07	0.04	0.14	0.15	0.41	_		
9	Ln Firm age	2.58 (1.07)	0.05	-0.03	-0.06	0.05	-0.17	0.01	0.37	0.05	_	
10	Ln IT age	2.16 (0.92)	0.06	0.01	-0.03	0.02	-0.13	-0.01	0.32	0.07	0.7	_

Table 4: Descriptive statistics of model variables; the diagonal values in bold represent average variance extracted; SD, Standard Deviation.

5.2 Hypothesis testing

Hypothesis 1a proposes that a leadership DDM style does not support higher levels of IT ambidexterity. The results show a significant positive relationship between a leadership DDM style and IT ambidexterity (β=0.20, p<0.001). Thus, H1a is not supported. Hypothesis 1b proposes that a leadership PDM style enables higher levels of IT ambidexterity. The statistical analysis provides clear support for hypothesis 1b; IT ambidexterity increased significantly with a leadership PDM style (β=0.36, p<0.001). Table 5 presents the results of our analysis.

Dependent variables	**Hypotheses**		**Independent variables**	**Estimate**	**S.E.**	**P**
IT Ambidexterity	<---	H1a	Directive decision-making (DDM)	0.369	0.056	***
IT Ambidexterity	<---	H1b	Participative decision-making (PDM)	0.201	0.068	***
IT Ambidexterity	<---		Organisational diversity	0.054	0.071	0.457
IT Ambidexterity	<---		Shared vision	0.04	0.064	0.532
Moderation						
IT Ambidexterity	<---	H2a	DDM × diversity	-0.166	0.066	0.003
IT Ambidexterity	<---	H2b	PDM × diversity	0.121	0.064	0.02
IT Ambidexterity	<---	H3a	DDM × shared vision	0.176	0.066	0.007
IT Ambidexterity	<---	H3b	PDM × shared vision	-0.112	0.068	0.585
Performance						
Organisational performance	<---	H4	IT Ambidexterity	0.329	0.044	***

Table 5: SEM analysis results of the research model. ***p<0.01.

Hypothesis 2a predicts higher organisational diversity to dampen the ability of a leadership DDM style to enable IT ambidexterity, whereas hypothesis 2b proposes that higher organisational diversity strengthens the ability of a leadership PDM style to enable IT ambidexterity. The interaction variable for organisational diversity is negative for the

leadership DDM style (β = -0.16, p<0.001) and positive for leadership PDM style (β=0.17, p<0.001). Thus, H2a and H2b are supported.

Hypotheses 3a and 3b propose that a higher shared vision among employees strengthens the ability of both leadership DDM and PDM styles to enable IT ambidexterity. The interaction variable for shared vision is positive for the leadership DDM style (β=0.12, p<0.001) and non-significant for the leadership PDM style (p>0.001). Thus, H3a is supported and H3b is not supported.

Hypothesis 4 proposes that IT ambidexterity will have a positive influence on organisational performance. Consistent with H4, our results indicate that IT ambidexterity has a significant and positive impact on organisational peformance (β=0.32, p<0.001).

6. Discussion

The literature on management and ambidexterity has taken a traditional perspective of leadership as an antecedent for ambidexterity (Raisch and Birkinshaw, 2008). The insight into how leaders actually manage the inevitable conflicts that arise when undertaking the contradicting activities of exploitation and exploration has become an important aspect to unveil (O'Reilly and Tushman, 2008). In an attempt to fulfil this research gap, we examine the leadership decision-making styles in enabling IT ambidexterity.

In a survey-based study of 292 high-tech SMEs in the UK, our results demonstrate contrary to pervading assumptions that a leadership DDM style may not enable higher levels of IT ambidexterity, our results do not support this expectation, and, interestingly, was opposite to our predictions. A significant positive relationship between the leadership DDM style and IT ambidexterity is observed. A plausible explanation for this unexpected finding could be understood with regard to social exchange theory (Blau, 1964) and cognitive evaluation theory (Deci and Ryan, 1985). Social exchange theory implies that if employees are satisfied

with their leaders, a leadership DDM style is more likely to offer clarity and guidance about their roles, which will increase their willingness to perform better and employees will reciprocate by taking proactive actions (Martin et al., 2013). Cognitive evaluation theory suggests that the leadership DDM style embodies both control and information. Hence, if the control factor is not particularly salient, the information component may become dominant. This results in providing a host of benefits, particularly in relieving the stress of uncertainty, reducing the role ambiguity, and increasing employee confidence and self-efficacy, which are significant determinants to enabling organisational ambidexterity (Lubatkin et al., 2006; Jansen et al., 2006). Moreover, in contrast to large firms, the lack of structural complexity and the low numbers of employees in high-tech SMEs may become a source of high social integration among firm members (Asheim, 2001). The leadership DDM style, when combined with the positive leader-employee relationship, may resemble a nurturing leadership style, where employees accept the leadership authority and leaders are caring and dedicated towards the growth of their employees (Martin et al., 2013). An environment of mutual understanding can assist organisations in meeting the challenges of enabling ambidexterity (Mihalache et al., 2014).

As expected, a leadership PDM style helps high-tech SMEs to enable a simultaneous pursuit of IT exploitation and IT exploration activities. This finding provides further credence to previous studies (Jensen et al., 2011; Raes et al., 2011; Mihalache et al., 2014), suggesting that employee participation and empowerment in decision-making can enhance employee motivation. This in turn helps to implement operational objectives in a systematic and efficient way.

To aid the interpretation of results, we followed procedures by Aiken and West (1991) to plot the significant interactions, as recorded in Figure 2. Figure 2(a) indicates that high levels of organisational diversity dampen the positive influence of the leadership DDM style on IT

ambidexterity. However, Figure 2(b) shows that high levels of organisational diversity enhance the positive relationship between the leadership PDM style and IT ambidexterity. These findings correspond to the findings of an empirical study by Somech (2006) that only participative leaders are positively associated with developing team reflections to foster team innovation in functionally heterogeneous teams.

Figure 2(c) shows that shared vision strengthens the relationship between the leadership DDM style and IT ambidexterity. This finding supports previous research findings and arguments that high levels of shared vision among employees contribute to resolving conflicts, ease of resource exchange, effective decision outcomes, and to achieving organisational ambidexterity (Jansen et al., 2008; Mihalache et al., 2014; Wang and Rafiq, 2009). On the other hand, the effect of shared vision is insignificant on the relationship between the leadership PDM style and IT ambidexterity. The possible explanation for the non-significant finding could be due to the fact that the leadership PDM style necessitates mutual discussions among firm employees, sets a common strategic direction, and ameliorates conflicts and disagreements (Sagie et al., 2002). Therefore, the influence and impact of organisational shared vision seems to already been incorporated into the leadership PDM style, resulting in an insignificant moderating effect of shared vision.

Finally, our results show that IT ambidexterity significantly enhances the organisational performance of high-tech SMEs. This finding demonstrates the significance of IT ambidexterity as a competitive IT capability that can create competitive advantage. Thus, our finding validates the theoretical arguments of Mithas and Rust (2016) that IT ambidexterity is a competitive capability for firms.

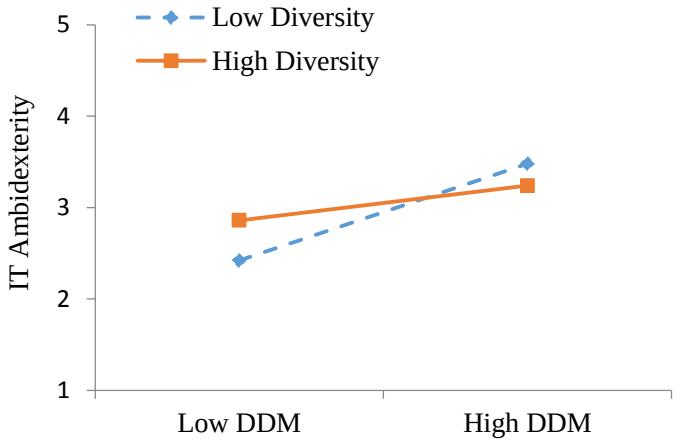

Figure 2(a). Moderating effect of organisational diversity

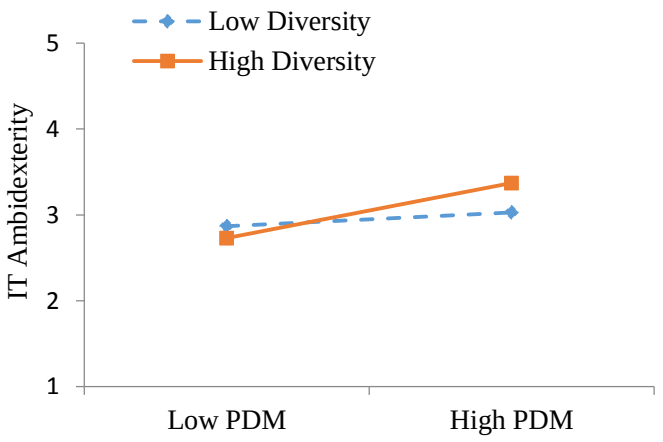

Figure 2(b). Moderating effect of organisational diversity

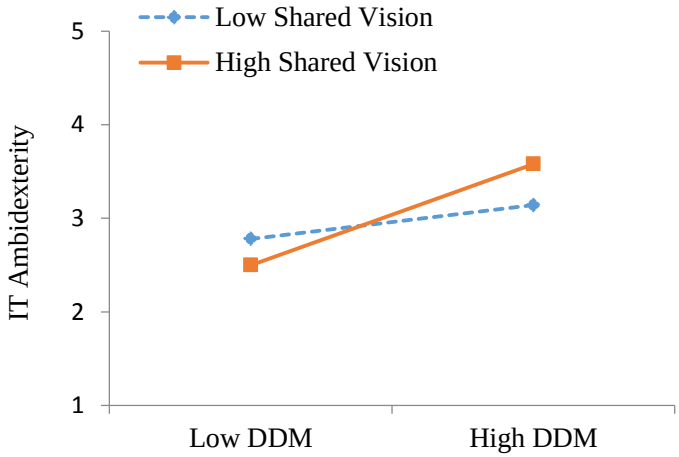

Figure 2(c). Moderating effect of shared vision

6.1 Theoretical and practical implications

First, this study contributes to management and leadership literature by highlighting the importance of leadership decision-making styles in enabling IT ambidexterity, thus responding to calls for the need to identify how leaders manage ambidexterity (Carmeli and Halevi, 2009; O'Reilly and Tushman, 2013). Our study identifies that, interestingly, both leadership DDM and leadership PDM styles enable IT ambidexterity. Although, the two leadership styles may achieve the same end, the mechanisms or means may be quite different. A leadership DDM style operates on providing firm members with guidance regarding goals, means of achieving goals, performance standards, and monitoring and providing appropriate feedback. A leadership PDM style, however, operates on the principles of developing the firm member's sense of autonomy and responsibility. These insights extend our understanding of the nature of mechanisms that facilitate these decision-making styles to enable ambidexterity.

Second, to elaborate on leadership contingency theory, this study examines the moderating roles of organisational diversity and shared vision on the relationship between leadership decision-making styles – IT ambidexterity. By doing so, we go beyond just focusing on whether a leadership DDM style or a leadership PDM style is more beneficial; instead, we inquire when these decision-making styles might be more or least effective. The high levels of organisational diversity strengthen the positive impact of the leadership PDM style on IT ambidexterity; however, it dampens the positive impact of the leadership DDM style. This complements the contingency theory that the appropriate leadership style depends upon the situation of the firm (Sims et al., 2009). The high level of shared vision strengthens the positive impact of the leadership DDM style on IT ambidexterity and the influence is non-significant on the impact of the leadership PDM style. These insights extend our

understanding of choosing the right decision-making style depending on the organisational factors.

Third, this study extends management literature by identifying a competitive framework for IT resources that are hard to imitate. This in turn widens the scope of ambidexterity in IS literature by examining the antecedents and performance impacts of IT ambidexterity. Considering the embryonic stage of literature on IT ambidexterity, we extend it by responding to calls for the need to understand the mechanisms that enable IT ambidexterity and test the impact on performance (Iyengar, 2007; Mithas and Rust, 2016). Our study validates the conceptual arguments that IT ambidexterity can be a strategic implementation of IT resources in order to achieve a competitive advantage (Gregory et al., 2015).

Finally, this study contributes to the on-going research in order to enhance the competitiveness in high-tech SMEs (Alegre et al., 2013). IT ambidexterity can be the strategic solution for competing successfully in frequently changing products and process technologies. Moreover, this study broadens the scope for researchers and practitioners to comprehend IT ambidexterity further as a source of competitive advantage and long-term survival.

6.2 Limitations and future research

The limitations of this study provide a gateway for future research. The findings and the contributions of the current investigation can be further evaluated, taking into account the potential limitations of the research design. First, the results of this study are constrained by the sample of firms and measures adopted for performance. This study focuses on high-tech SMEs, and although the selection is defendable within the context of measuring the impact of IT ambidexterity, additional insights and further validation can be gained by using a more diverse sample of firms. The measures used for organisational performance are accepted as

reliable and valid; however, precise and in-depth insights may be gained by adopting objective performance measures. Moreover, the research model is evaluated on the basis of data collected from UK firms only. Future research may assess similar models for multiple sectors, cultures and, perhaps specifically, from multinational enterprises, potentially providing an extremely informative validation for our results. Finally, longitudinal designs in which both predictor and criterion variables are measured over time might particularly be useful extensions of the current study.

6.3 Conclusion

Notwithstanding the limitations of the research, this study provides strong evidence that leadership decision-making style plays a critical role in enabling simultaneous and balanced pursuit of distinct IT exploitation and IT exploration activities. Noteworthy is the finding that IT ambidexterity is associated with enhanced firm performance. This is a potential extension to the Leidner et al. (2011) post-hoc analysis and a contribution to our study. By examining the effects of leadership PDM and DDM styles, our results have developed a comprehensive understanding of how leadership decision styles matter, especially in deploying IT resources for competitive advantage. Instead of depicting leadership capabilities, skills and traits, we highlight practices for enabling IT ambidexterity. Leaders need to realise the impact of their decision-making styles upon their employees' commitment levels and the success to implement contradictory IS strategies. Furthermore, this study evaluates the influence of firm internal characteristics on the decision-making styles. Organisational leaders should consider adopting decision-making styles to synergise with the levels of organisational diversity and shared vision. A leadership PDM style is preferable within the context of a highly diverse or heterogeneous workforce, whilst if shared vision is a dominant factor in the firm, adopting a leadership DDM style could be more effective. Finally, firms should take advantage of IT ambidexterity in order to develop and sustain competitive advantage.

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CHAPTER 4

Chapter 4 | IT ambidexterity to IT performance in SMEs: What role do internal and external contingencies play?

Abstract

Following the investigation of antecedents for enabling IT ambidexterity in high-tech SMEs in previous two chapters, this chapter focuses to investigate the impacts that IT ambidexterity will have on performance outcomes.

This chapter seeks to advance research on IT ambidexterity by investigating how a balanced and simultaneous pursuit of IT exploitation and IT exploration affects IT performance in high-tech SMEs. To explicate the effect of IT ambidexterity on IT performance, this study draws on a combination of the resource-based views and contingency theories to develop a conceptual framework that investigates the moderating effects of a firm's internal and external contingencies on the IT ambidexterity-IT performance relationship. A sample of 292 UK based high-tech SMEs shows that the positive effect of IT ambidexterity on IT performance is amplified in firms with more resources and with higher levels of environmental dynamism, complexity and munificence. Interestingly, our results show that the performance implications of IT ambidexterity are not age-dependent, suggesting, therefore, that high-tech SMEs should be concerned about the available resources instead of the firm age when seeking to benefit from IT ambidexterity posture. Finally, we discuss important ramifications for theory and practice, while highlighting future research directions.

Key words: IT ambidexterity, IT department performance, external contingencies, internal contingencies

1. Introduction

Research on IT ambidexterity has steadily expanded since Subramani (2004) recognised this phenomenon as one of the key sources of competitive performance. IT ambidexterity refers to the capability of the firm to exploit its exiting IT resources (IT exploitation) and explore new IT solutions (IT exploration) at the same time (Lee et al., 2015). IT ambidexterity reflects a firm's willingness to simultaneously search new IT resources and practices and refine its current IT resources and practices. In accordance to the resource-based view (RBV) of the firm (Barney, 1991), IT ambidexterity is a socially complex and imperfectly imitable resource due to the enhanced breadth and depth of relationships (Mithas and Rust, 2016) that generate competitive advantage and deliver better performance (Subramani, 2004; Lee et al., 2015). The traditional view asserts that IT ambidexterity enhances IT effectiveness; however, to the best of our knowledge, there are no empirical studies to verify the effect of the simultaneous pursuit of IT exploitation and IT exploration on IT performance. The proliferation of technological tools in current industries has reinforced the need to measure the effectiveness of IT resources (Nambisan, 2013), and in particular small and medium enterprises (SMEs), where optimal IT performance becomes essential to ensure their competitiveness and survival (Parker and Castleman, 2007). The absence of evidence enforces the need for empirical research in this area. In a more extensive examination of this link, we focus on organisational internal and external contingencies that may enable or inhibit the performance implications of IT ambidexterity. In other words, it is essential to determine whether the relationship between IT ambidexterity and IT performance depends upon the firm's internal or external factors.

The paucity of research into organisational internal and external contingencies that might underlie the performance impacts of an ambidextrous posture remains a serious dilemma (De Clercq et al., 2013). This study advances the argument that attaining the potential

performance benefits of an ambidextrous posture depends upon an internal context that facilitates the intrafirm resource flow (De Clercq et al., 2013) and external environments that influence the opportunities for and the constraints on this relationship (Caspin-Wagner et al., 2012; Cao et al., 2009). For instance, Lawrence and Lorsch (1967) find a difference in the economic performance of six organisations operating in the same industrial environment. The comparative analysis of these firms reveals that the high performance outputs are dependent on the extent to which the organisation subsystem structures are aligned with the external environment (Lawrence and Lorsch, 1967). Similarly, the role of organisational internal and external contingent factors may play an important role in the performance realisations of IT ambidexterity. Thus, we use the combination of the contingency theory and RBV to measure the impact of IT ambidexterity on IT performance. The combination of the contingency theory and RBV asserts that the usefulness of any particular resource is contingent upon the internal and external organisational factors (Cao et al., 2011). This perspective implies that internal and external characteristics of the firm should be considered when attempting to explain the effect of organisational strategies on organisational outcomes (Tsai and Yang, 2013). Johns (2006) emphasises the significance of context (i.e. internal and external characteristics) and states that organisational context affects the organisational behaviour and functional relationships among construct variables. Thus, this study proposes that organisational internal and external contingencies may moderate the strength of IT ambidexterity-IT performance relationship. By examining this link, we respond to the call for more research on how strategic resources interact with the firm's internal and external characteristics to effect performance outcomes (Johns, 2006; De Clercq et al., 2013). To remedy these deficiencies and obtain insights into performance implications of IT ambidexterity, this study addresses two critical questions:

Q1: How does IT ambidexterity affect IT performance?

Q2: How do firms' internal and external contingencies moderate the IT ambidexterity-IT performance relationship?

This study examines these research questions based on a survey of 292 SMEs from the high-tech sector in the United Kingdom. The choice of SMEs is due to the fact that, in contrast to larger firms, SMEs are limited in their ability to create separate structures or buffers for exploration and exploitation activities that conceal performance problems (Voss and Voss, 2013). Moreover, Parker and Castleman (2007) argue that SMEs tend to adopt novel technologies more swiftly to remain competitive, and emphasise developing innovative products for survival. Furthermore, technological exploitation and exploration is a key forte, as the annual report on European SMEs states that the magnitude of net employment loss is inversely related to the degree of technology intensity of SMEs (Muller et al., 2014). Finally, little research on ambidexterity strategies and their influence on performance has focused on SMEs (De Clercq et al., 2014).

This study contributes to the literature of IT ambidexterity and SMEs studies by illustrating the role of IT ambidexterity in enhancing the IT performance in high-tech SMEs. The findings of this study identify whether and how performance impacts of IT ambidexterity depend on internal and external firm characteristics. This focus uncovers the boundary conditions for the IT ambidexterity-IT performance relationship. Consequently, this study offers beneficial and extensive implications for theory and practice.

The remainder of this paper is as follows: Section 2 discusses relevant literature for our research questions, followed by the research framework and hypothesis development in Section 3. The research methodology is discussed in Section 4. Section 5 presents data analysis and results, followed by discussion, conclusion, and future research avenues in Section 6.

2. Theoretical background

2.1 IT ambidexterity

IT ambidexterity refers to the ability of the firm to simultaneously balance differing and competing trade-off activities (Lee et al., 2015). This study discusses the trade-off between exploitation and exploration activities, as these are the most commonly used and widely accepted in ambidexterity literature (March, 1991; He and Wong, 2004; Jansen et al., 2006; De Clercq et al., 2013; Lee et al., 2015). IT exploitation represents the continuous refinement, modification and reconfigurations of existing IT resources, while IT exploration represents innovating, experimenting and creating new IT solutions and IT practices (Lee et al., 2015; Subramani, 2004). IT exploration and IT exploitation activities draw on dissimilar processes, resources and structures, generating significantly different performance outcomes over time (He and Wong, 2004). The competitive and environmental pressures may tend to lead SMEs to focus too much on IT exploitation, thus leading to short-term profits trap. Similarly, firms focusing too much on IT exploration may lead to ignoring exploitation opportunities. The firms falling prey to these traps may result in experiencing performance difficulties i.e. Motorola (Holmes, 2008). IT ambidexterity overcomes these traps with balanced and simultaneous focus on IT exploitation and IT exploration, resulting in higher performance in high-tech industries (He and Wong, 2004; O'Reilly and Tushman, 2008). Although some of the nascent work in IS literature has started to examine various notions of IT ambidexterity, i.e. (Mithas and Rust, 2016; Gregory et al., 2015; Heckmann, 2015; Lee et al., 2015) and these studies argue the positive impacts of IT ambidexterity, there is no empirical evidence of whether IT ambidexterity enhances the capabilities of the organisational IT department.

2.2 The RBV and contingency theory

Drawing on the RBV theory, Mithas and Rust (2016) assert that the simultaneous pursuit of two seemingly opposing IT strategies may constitute a valuable, rare, imperfectly imitable

and non-substitutable resource that leads to a better firm performance. They argue that IT ambidexterity combines social complexity, causal ambiguity, path dependence and organisational learning that can protect it from imitation, substitution and transfer. Thus, IT ambidexterity becomes a valuable resource that assists firms to gain competitive advantage (Subramani, 2004; Mithas and Rust, 2016). On the contrary, some of the nascent studies on the RBV perspective increasingly emphasise the influence of organisational contingencies on resource usefulness. For instance, Barney (2011) argues that traditional RBV holds on a condition that the rules and environment of the industry remains relatively fixed. For any particular firm with specialised technological resources, the change in the internal or external environment may drastically change the significance of the resources in the firm (Tsai and Yang, 2013; Barney et al., 2011). Therefore, the value and performance impact of the firm's strategic resources must be evaluated in the internal and external organisational context within which the firm operates (Tsai and Yang, 2013). These arguments suggest the need to consider the effect of internal and external organisational conditions that may influence the value of strategic firm resources, such as IT ambidexterity. Thus, this study takes into account the firms' internal and external contingencies to measure the performance of IT ambidexterity.

2.2 Internal contingencies

To represent the constraint necessitating between exploration and exploitation, the seminal work of ambidexterity pioneer, March (1991), suggested that available resources could be the most significant firm's internal contingency variable that may undermine an ambidextrous posture. In other words, resource constraints can confine the performance realisations of ambidexterity (Goosen et al., 2012; Lubatkin et al., 2006). Based on aforementioned arguments, this study selects organisational size and organisational age as internal contingency factors. This is because organisational size and organisational age represent the

internal factors that directly relate to the amount of resources, capabilities and experience the firm possesses in order to successfully implement ambidextrous strategies (Voss and Voss, 2013). Moreover, previous studies emphasise the need to consider the role of organisational size within SMEs. For example, Brown and Kaewkitipong (2009) find that organisational size remains a significant factor in determining SMEs strategic use of IT, not only in comparison to large firms, but also within the SME sector itself. Similarly, Laforet (2013) reports a significant inverse relationship between organisational size and innovation impact within SMEs. Furthermore, organisational size and organisational age represent the two most common contingent factors in empirical studies of ambidexterity and performance (He and Wong, 2004; Jansen et al., 2006; Cao et al., 2009; Lee et al., 2015; De Clercq et al., 2013). Finally, the traditional view asserts that organisational size and organisational age tend to enhance the performance impact of ambidexterity (Voss and Voss, 2013); however, empirical research has not yet reached a consensus on this assertion. Some studies have failed to find a significant role of organisational size on the ambidexterity-performance relationship i.e. (Lubatkin et al., 2006; Jansen et al., 2006; Venkatraman et al., 2007). Similar to research examining the effect of organisational size, researchers have reached contradictory conclusions for organisational age, asserting the view that as firms age they become more institutionalised and grow rigid in their established set of routines, resulting in lack of R&D and performance impacts i.e. (Loderer and Waelchli, 2010; Thornhill and Amit, 2003). The aforementioned reasons and inconsistent findings reinforce the need for further research in organisational size and organisational age as firms' internal contingency factors.

2.3 External contingencies

Organisations operate within external environments; external environmental contingencies may often influence the prospects in favour or against of ambidexterity and its effect on performance (Cao et al., 2009; Simsek, 2009; Raisch and Birkinshaw, 2008). Scholars argue

that better performance may be achieved when the firms adapts to their external environmental conditions (Raisch and Birkinshaw, 2008). The organisational strategies are mostly determined in accordance with the organisational environment (Jansen et al., 2006; Chang et al., 2008; Ojala, 2015). Most of the research focuses on environmental uncertainty that relates to the firm's inability to predict its environment accurately due to lack of information (Anderson and Tushman, 2001; Dess and Beard, 1984). Focusing on environmental dimensions that generate environmental uncertainty, and building on previous research, Dess and Beard (1984) identify environmental dynamism, environmental complexity and environmental munificence as the main attributes of environmental uncertainty. They define environmental dynamism as the level of instability in the environment, environmental complexity as the interdependence among firm decisions or actions, and environmental munificence as the growth opportunities provided by environments (Dess and Beard, 1984). McArthur and Nystrom (1991: 349) emphasise the importance of these environmental dimensions and argue that they are critical in evaluating the relationship between strategies and performance. The empirical studies in organisational ambidexterity literature typically focus on environmental dynamism and environmental munificence, but ignore the potential effects of environmental complexity and the combined effect of all three environmental factors. For example, Jansen et al. (2006) measure the effects of environmental dynamism, Cao et al. (2009) measure for organisational munificence, and Tempelaar and Van De Vrande (2012) include the contingent effect of dynamism and munificence. Fulfilling this gap, we assess all three environmental dimensions together in terms of their moderating role on the relationship between IT ambidexterity and IT performance.

3. Research model and research hypothesis

This study draws on the combination of contingency theory and RBV to propose that the impact of IT ambidexterity on IT performance may depend on organisational internal and external contingencies. Figure 1 represents the research framework and illustrates the moderating roles of organisational size, organisational age, environmental uncertainty, environmental complexity and environmental munificence on the relationship between IT ambidexterity and IT performance.

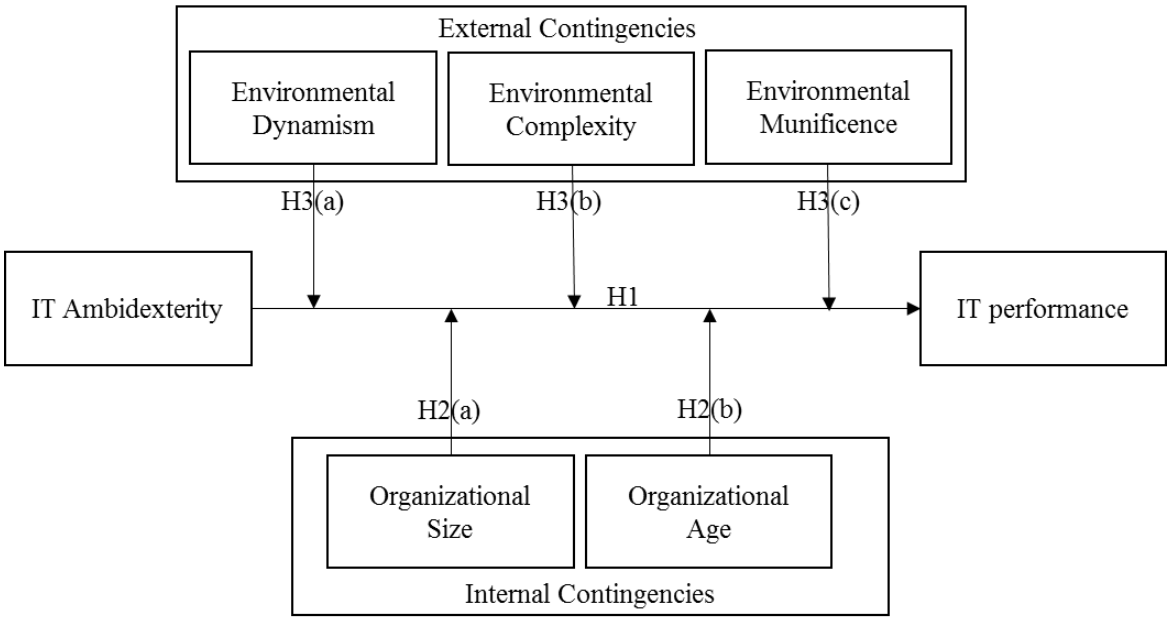

Figure 1: Research model

3.1 IT ambidexterity and IT performance

It has been well recognised that IT has become a major instrument and a key platform in shaping firm competitiveness (Melville et al., 2004; Sambamurthy et al., 2007). The organisational IT department, therefore, holds a fundamental role as an operant resource for competitiveness (Nambisan, 2013; Chang et al., 2008). This study proposes that IT ambidexterity can boost the performance of the IT department in order to meet firm competitive desires. In accordance with the RBV perspective, the simultaneous pursuit of

refining existing IT capabilities and harnessing new IT opportunities results in the development of a strategic resource that is hard to imitate (Mithas and Rust, 2016). IT ambidexterity enriches the firm's IT department to adapt to changing environments, reduces risk for core technology becoming obsolete, and creates essential capabilities for survival and long-term prosperity through IT exploration, while at the same time extending new IT solutions by reconfiguring, modifying and refining existing IT resources and improving adaptation to current environments through IT exploitation (Walia and Haried, 2007). For instance, IBM has been able to compete in mature as well as new businesses and technologies through simultaneous exploitation and exploration (O'Reilly et al., 2009). IT ambidexterity enhances the efficiency of the IT department through not only the effective deployment of existing IT resources and refining established practices, but also by directing attention towards emerging technologies, methodologies and IT skills (Lee et al., 2015). In other words, it enhances the effectiveness and efficiency of the IT department with a continuous effort to seamlessly integrate exiting IT infrastructure and applications with the new technological initiatives (Lee et al., 2015). The balanced pursuit of IT exploration and IT exploitation activities in the organisational IT department may lead firms to achieve higher competitiveness (Subramani, 2004) and facilitate organisational agility (Sambamurthy et al., 2007; Lee et al., 2015). Therefore, IT ambidexterity may help the organisational IT department to exploit existing technologies and explore novel IT solutions in order to enhance the firm's competitiveness. Hence, we propose the following:

H1: IT ambidexterity has a positive influence on organisational IT performance.

3.2 The moderating effect of internal contingencies

Organisational size represents the resources, transaction volumes, or workforce size the firm possesses at its immediate disposal (Kimberly and Evanisko, 1981). It is therefore a stock of available resources that mitigates the effects of risks and shocks (Moch and Morse, 1977).

Resources play an important role in bolstering firm activities and represent the organisation's economies of scale (Lee and Xia, 2006). The relationship of IT ambidexterity-IT performance may also be contingent on organisational size because IT exploitation and IT exploration are characterised as diverse organisational activities and may involve different sets of supportive resources (March, 1991). The firms may frequently face strategic decisions that involve a trade-off between IT exploration and IT exploitation activities. This is to decide on the amount of resources to be allocated for refining the existing IT resources and the development of new IT solutions. For example, Mettler-Toledo, a Swiss company, was a market-leading industry in manufacturing mechanical balances for scientific measurements. To manage the technological transition from mechanical to electronic scales, the company exploited their existing resources to manufacture mechanical balances, and at the same time explored electronic instruments. They were able to manufacture both types of scales until customer demand for mechanical balances gradually diminished (O'Reilly and Tushman, 2008). Kyriakopoulos and Moorman (2004) and Voss and Voss (2013) argue that the success of ambidexterity may depend on the extent to which sufficient resources can be accessed and allocated to support both activities at the same time. Thus, the availability of slack resources should positively affect the positive outcomes of IT ambidexterity. On the other hand, resource constraint firms may find it difficult to pursue exploitation and exploration at the same time (Lin et al., 2007). Small firms may have low coordination costs and less hierarchy; however, lack of in-house IT personnel and expertise, tight IT budgets, and short-range management perspectives result in creating barriers to IT innovation (Lee and Xia, 2006). These firms may be constrained in their attempt to provide sufficient resources to support technological exploitation and exploration activities at the same time, resulting in depriving themselves of the resources necessary to maintain a required level of engagement (Cao et al.,

2009). Thus, resource constrained firms may not fully realise the prospering impacts of IT ambidexterity. Based on the above arguments we propose the following hypothesis:

H2a: Organisational size positively moderates the relationship between IT ambidexterity and IT performance.

The second internal contingency variable is organisational age, as it has been associated with the institutional routines and norms that engender inertial behaviour. Older firms may grow rigid in their established routine and lack innovation (Loderer and Waelchli, 2010). On the contrary, however, older firms may also build on refining old technologies to create innovative initiatives (Sørensen and Stuart, 2000). Either way, the influence of organisational age becomes an important factor when examining the IT ambidexterity-IT performance relationship. IT ambidexterity is associated with the approach in managing the complexities and tensions associated with balancing IT exploration and IT exploitation at the same time (Lee et al., 2015). This approach requires contextual support, behavioural repertoire, structural support and high-order meta-level capacities (Raisch and Birkinshaw, 2008). These capabilities may well develop in small firms; however, they require substantial time and experience to foster dual strategies (March, 1991; O'Reilly and Tushman, 2008). As argued, "at any time within a given domain, a firm may emphasise either exploration or exploitation, yet across domains and over time, balance is maintained" (Lavie and Rosenkopf, 2006: 815). Even after the simultaneous pursuit of IT exploration and IT exploitation has been developed, the realisation of the benefits of these capabilities requires an extended time frame (Van Looy et al., 2005). These arguments advocate that in contrast to younger firms, older firms will have developed the required knowledge, gained the experience, and have had the time to develop IT ambidexterity and realise the implications of IT ambidexterity on IT performance. Voss and Voss (2013) argue that as the benefits of ambidexterity require an extended time, older firms will enhance their performance (measured in terms of revenue), while the younger

firms' performance might suffer. In synthesising the aforementioned arguments into a coherent whole, the value of IT ambidexterity is much more likely to be realised by older firms rather than younger ones. Hence, we posit:

H2b: Organisational age positively moderates the relationship between IT ambidexterity and IT performance.

3.3 The moderating effect of external contingencies

The inconsistency in the performance implication of ambidextrous orientation has led researchers to focus not only on organisational internal contexts, but also to include the effect of organisational external contingencies (Simsek, 2009). Researchers have argued that it is necessary to consider environmental factors when studying organisational strategies in relation to performance implications (Cao et al., 2009; Tempelaar and Van De Vrande, 2012; De Clercq et al., 2013) as the viability of organisations "depends upon their ability to master the challenges posed by environments" (Miller and Friesen, 1983: 230). Hence, we explicate the influence of the environmental dynamism, complexity and munificence on the IT ambidexterity-IT performance relationship.

Organisational dynamism represents the instability of environmental change (Dess and Beard, 1984). It is most commonly composed of the market and technical instability (Anderson and Tushman, 2001). The former is linked to the unpredictability in customer preferences or demand for certain products, while latter is related to volatility in technological breakthroughs. This is seen, in particular, in high-tech SMEs where rapid technological change coupled with radical market changes have become increasingly evident (Alegre et al., 2013). In these environments, technological intensive firms may face significant threats related to the substantial depreciation in the value of particular technological solutions (Lin and Chang, 2015). Conversely, Wiklund and Shepherd (2005)

argue that high environmental dynamism creates new opportunities in markets for firms to grow. In either of these cases, environmental uncertainty may intensify the importance of IT ambidexterity in high-tech SMEs. A firm with the dual pursuit of IT exploitation and IT exploration may avoid existing technological solutions from depreciating through continuous improvement and may as well grow in market value by introducing new technological solutions (Lee et al., 2015). Moreover, to survive in high volatile environments, a fluctuating market demand requires high-tech SMEs to rapidly adjust (Walia and Haried, 2007; Alegre et al., 2013). IT ambidexterity may lead to operational innovativeness and improvement that help organisations to develop adaptive responses quickly and to expand the scope of information acquisition and gathering (Lee et al., 2015). Firms tend to be exposed to higher pressures for technological development and organisational agility in high levels of environmental dynamism (Dess and Beard, 1984; Anderson and Tushman, 2001). The performance implications of IT ambidexterity may increase under such conditions because an ambidextrous pursuit enables firms to achieve competency against their competitors (Jansen et al., 2006). In contrast, in low environmental dynamism, the competitive intensity pacifies, and the firms' approaches to their markets get simpler. Thus, the value of capability-building processes will be weaker. Consequently, in low environmental dynamism, the relationship between IT ambidexterity and IT performance may be weaker than that in high environmental dynamism because the need to achieve the better performance from the IT resources will be less significant. Synthesising the above-mentioned arguments, the positive relationship between IT ambidexterity and IT performance intensifies under high environmental dynamism.

H3a: Environmental dynamism positively moderates the relationship between IT ambidexterity and IT performance.

Environmental complexity represents the extent to which a firm has to consider its range of activities, heterogeneous actors, linkages and interconnectedness outside its boundaries in making strategic decisions (Dess and Beard, 1984). A complex environment will be perceived as more uncertain and thus requiring more information processing than a simple environment (Anderson and Tushman, 2001; Dess and Beard, 1984). To compete in complex environments, firms are expected to gather information about their surroundings and possess information-processing mechanisms to adapt and co-evolve with the environment (Ashmos et al., 2000). Thus, the performance-effects of a simultaneous pursuit of IT exploration and IT exploitation may become more evident in a highly complex environment than in a simple environment. For example, in simple environments, the likelihood of sustaining a competitive advantage of existing technologies over an extended period is high. Under such circumstances, high-tech firms may not emphasise the need to continuously refine existing, or explore new, technological resources (Walia and Haried, 2007). On the other hand, in a more complex environment, firms may face intense pressures to exert increased efforts in not only refining existing technological resources but also innovating new technical solutions to sustain the competitive advantage (Ashmos et al., 2000). In particular, in high-tech SMEs that tend to compete on their operational agility and respond rapidly to changing demands (Alegre et al., 2013), the higher complexity may require them to process more information for decision making (Dess and Beard, 1984). The firms attempt to absorb the complexity through the development of multiple and sometimes conflicting strategic activities (i.e. IT ambidexterity) so as to adjust and co-evolve with the environment (Ashmos et al., 2000). Similarly, Simsek (2009) argues that as the simple strategies may not suffice in complex environments, the influence of complex environments increases the emergence and performance effect of ambidextrous orientations. Thus, IT performance can be expected to improve under high environmental complexity as the need for IT ambidexterity intensifies, in

contrast to simple environments, where it may not necessarily be essential. Therefore, we propose the following hypothesis:

H3a: Environmental complexity positively moderates the relationship between IT ambidexterity and IT performance.

Environmental munificence represents the extent to which an environment can support sustained growth and stability (Dess and Beard, 1984). The munificent environment delivers an increased growth opportunity to firms by providing easy and low cost access to external (financial, human and relational) resources needed to support complex activities (Anderson and Tushman, 2001). An organisation might be highly susceptible to risks subsequent to a lack of balance between exploration and exploitation activities unless it has ample buffering resources (Cao et al., 2009). Specifically, SMEs may evade the resource constraints that could have stranded their ability to explore and exploit at the same time. The abundant resources allow firms to generate slack resources and expand in terms of scale and scope (Goll and Rasheed, 2005). For example, IT infrastructure provides a key competitive advantage; however, it takes much time to develop these capabilities. The firms can quickly grow by purchasing IT infrastructure services to scale their expansion in a munificent environment (Qu et al., 2011). Empirical evidence and theoretical research mutually agree that environmental munificence has a pervasive influence on organisational strategies and performance impact (Goll and Rasheed, 2005). On the other hand, low munificent environment poses numerous challenges to high-tech SMEs. Resource-scarce environments may confine organisational growth and intensify competition to acquire technological capabilities (Qu et al., 2011). The lack of IT personnel, IT infrastructure and IT resources may constrain the performance effects of IT ambidexterity. Cao et al. (2009) argue that under low munificent environments firms face a critical challenge, especially in balancing exploration and exploitation activities, as they cannot rely on environmental sources for

resources support. A resulting imbalance between exploitation and exploration activities may lead firms to performance difficulties i.e. Motorola (Holmes, 2008). Dess and Beard (1984) appraise environmental munificence to be a substantial predictor of firm profitability, regardless of firm strategy. Therefore, we propose the following hypothesis:

H3a: Environmental munificence positively moderates the relationship between IT ambidexterity and IT performance.

4. Research methods

4.1 Sample and data collection

The initial sampling frame of this study consists of 1000 UK small and medium-sized (1-249 employees) high-tech firms[9], all of which were randomly selected from the FAME database. The primary reason for the choice of UK SMEs is because the British Government reports that SMEs account for more than half of employment (59.8 per cent), and almost half of the annual turnover (49.0 per cent) in the UK (Department for Business Innovation Skills, 2009). Moreover, the UK government is currently running a very large initiative called "living innovation" to encourage innovation in SMEs in particular (Oke et al., 2007). Finally, the UK government reports that 99.8 per cent of all businesses in the UK is represented by SMEs (Department for Business Innovation Skills, 2011). The high-tech sector is well suited for several reasons. First, the high-tech sector among UK SMEs plays a pivotal role in the UK and European economy. As the annual report on European SMEs states, UK high-tech SMEs post the strongest combined performance in value added and performance growth (Muller et al., 2014: 22). Second, the technological innovation imperative is very strong in this sector and plays a key role in sustaining and enhancing their competitiveness (Parker and

[9] The high-tech firms in this study includes precision equipment manufacturers, computer and electronic product manufacturing, control instrument manufacturing, telecommunication, medical equipment and supplies manufacturing, and optics apparatus, all of which are included in NAICS 2012 industry classification under codes 33,51 and 54.

Castleman, 2007). Third, the high-tech industries provide a rich context to examine the influences of uncertainty, complexity and munificence, which are common characteristics of high-tech environments (Mohr et al., 2009; Tsai and Yang, 2013). Finally, given that IT ambidexterity is more important in high-tech industries (Chandrasekaran et al., 2012; Ribeiro Soriano et al., 2011), examining whether and when IT ambidexterity improves IT performance in this sector potentially yields meaningful new insights. Thus, UK high-tech SMEs represent an appealing and critical context in which to examine our research objectives and expand our understanding of IT ambidexterity. IT decision-making authorities on spending/purchasing in IT hardware and IT software in the sample of high-tech firms were selected as key informants for data collection, owing to their knowledge of the processes, activities, internal and external pressures and overall technological performance of their firms. The key informants were contacted through emails and telephone calls so as to describe the research objectives and purpose of this study. The online questionnaire link was then directly emailed to the participants who agreed to participate in this study. The cover letter that accompanied the questionnaire described research objectives and assured the respondents that their responses would remain anonymous and confidential. After week three and week five, a follow-up reminder was e-mailed with the questionnaire link to the firms that had not yet responded.

After two follow-up reminders, the data obtained was screened for incomplete information, missing data values and unengaged responses (evidenced by finding the exact same response for every item). 292 responses were found complete and valid after data screening constituting 29.2 per cent response rate. The industry characteristics in which these IT ambidextrous firms operate are provided in Table 1.

To detect a potential effect of non-response bias, we examined differences between respondents and non-respondents for our final sample. T-tests showed no significant differences based on the number of full-time employees, industry sector (service versus manufacturing) and firm age. We also compared early respondents (those who submitted the questionnaire during the first week of data collection) and late respondents (those who submitted the questionnaire during the last week of data collection), in terms of construct variables. These comparisons revealed no significant differences ($p < 0.05$) between the two groups, indicating that non-response bias was not a problem in this study.

Firm characteristics	**Frequency**	**Percentage**
Computer and peripheral equipment	94	32.2
Communications equipment	47	16.1
Semiconductor and electronic components	51	17.5
Medical equipment and supplies	32	11.0
Industrial and precision equipment	41	14.0
Optics apparatus	27	9.2
Firm size		
Small (1-49)	160	54.8
Medium (50-249)	132	45.2
Firm age		
Less than 5 years	55	18.8
Between 5 - 10 years	51	17.5
Between 10 - 15 years	84	28.8
More than 15 years	102	34.9
Firm Type		
Service	125	42.8
Manufacturing	167	57.2

Table 1: Characteristics of respondent industries

4.2 Measures

All the constructs in this study were measured using, or adapting to, the previously developed and tested scales in the literature. A five-point Likert scale was used to measure constructs. Respondents were asked to indicate the extent to which they agreed with the scale items on a scale ranging from "1 = strongly disagree" to "5 = strongly agree". The table below presents the measures for all the constructs in this study.

IT Exploitation (CA[10]=0.85, CR[11]=0.92, AVE[12]=0.68)	Factor loadings
Our firm frequently refines the existing level of IT components, such as hardware and network resources.	0.78
Our firm reuse existing IT skills.	0.70
Our firm improves existing IT applications and services.	0.70
Our firm continually expands existing IT services for existing clients.	0.80
IT Exploration (CA=0.94, CR=0.95, AVE=0.66)	
Our firm pursues innovative applications of IT.	0.82
Our firm experiments and develops unique IT applications.	0.85
We frequently utilise new opportunities through new IT services.	0.88
Our firm accepts demands that go beyond existing level of information services.	0.89
Our firm regularly searches for and acquires new IT resources (e.g., new generation of IT architecture, potential IT applications, and critical IT skills).	0.87
Our firm experiments with new IT management practices.	0.89
Environmental dynamism (CA=0.94, CR=0.89, AVE=0.71)	
Product or service in our industry updates quickly.	0.78
Our clients regularly ask for new products and services.	0.74

[10] Cronbach's Alpha
[11] Composite Reliability
[12] Average Variance Explained

The technology in our industry progresses rapidly and unpredictably.	0.88
A large number of new products have been made possible through technological breakthroughs.	0.80
Environmental complexity (CA=0.87, CR=0.81, AVE=0.68)	
In our industry, there is considerable diversity in customer buying habits	0.77
In our industry, there is considerable diversity in product lines	0.74
There has been a frequent change in firm suppliers.	0.88
The legal regulations have frequently changed the way our firm conducts business.	0.88
Environmental munificence (CA=0.88, CR=0.85, AVE=0.67)	
Our firm is in the market with numerous profit opportunities.	0.72
Our firm is in the market with sufficient capital (i.e. human, relational etc.) supply.	0.66
Our firm is in the market, which can easily access to the needed resources for the operation and expansion.	0.85
Our firm is in the market almost without external threat to the survival and development of firms.	0.73
IT Performance (CA=0.90, CR=0.90, AVE=0.65)	
Efficiency of IT services	0.77
Reliability of IT services	0.71
Perceived utility of IT services	0.87
IT impact on business goals	0.85
IT contribution to organisational financial performance	0.78

Table 2: Measurement items statistics

4.3 Dependent variables

IT performance: IT performance assesses the performance of IT services that are provided by the IT department of the firm. Adopting the five-item scales (α=0.90) from Bernroider (2008), IT performance is measured by asking the respondents about the level of satisfaction with the services provided by their IT department in terms of reliability, efficiency, impact on business, and contribution to financial performance. The self-reported data for IT performance is used because the objective performance data of privately held firms is not accessible, and also owing to the positive correlation between objective performance measures and perceived performance measures (Menguc and Auh, 2006).

4.4 Independent variables

IT ambidexterity: Following prior studies, we adopted the two-step approach to measuring IT ambidexterity (Lubatkin et al., 2006).

First, IT exploitation and IT exploration were measured independently by adopting the existing scales from Jansen et al. (2006) and Lee et al. (2015) to suit the research context. A four-item scale that measured IT exploitation (α=0.85) assessed the extent to which the IT department builds on existing IT resources and refines available technological resources to meet the demands of existing customers. A six-item scale that measured IT exploration (α=0.94) captured the extent to which the IT department departs from existing technical knowledge and innovates new technological practices for emerging customers.

Second, we sought the most interpretable approach for combining the measures of IT exploitation and IT exploration to construct the measure for IT ambidexterity. Previous studies suggest that ambidexterity can be measured by either multiplying (Gibson and Birkinshaw, 2004), subtracting (He and Wong, 2004) or summing (Lubatkin et al., 2006) exploitation and exploration measures. Therefore, we followed the approach recommended

by Edwards (1994), and that has been used in several previous studies (Jansen et al., 2009; Lubatkin et al., 2006), to choose the best method of combination. We ran four regression analyses with IT performance as a dependent variable. First, an unconstrained regression with IT exploitation and IT exploration as separate independent variables followed by three constrained regression models with the combination of IT exploitation and IT exploration in a single index. This was done by first multiplying IT exploitation and IT exploration, then by subtracting IT exploitation from IT exploration, and finally by adding the two. The comparison of the R^2 difference and the F values of three models with the unconstrained model revealed an additive approach superior. The additive approach showed the lowest lack of significant information, as compared to the unconstrained model with the higher R^2 value of 0.15.

Internal contingencies: Following prior studies, we measure *organisational size* by taking the natural logarithm of the number of full-time employees in the firm (He and Wong, 2004; Jansen et al., 2006; Lee et al., 2015). *Organisational age* is measured by taking the natural logarithm of the number of years since the firm's establishment (Jansen et al., 2006; Laforet, 2013).

External contingencies: The four-item scale of *environment dynamism* (α=0.94) was adopted from Dess and Beard (1984). The scale captures the extent of unprecedented market behaviour and technological progress in the industry. The four-item scale for *environmental complexity* (α=0.87) is adapted from Chen et al. (2014) and Hanisch and Wald (2014) that measures the extent to which the average range of organisational activities are increased as a result of firm actions that affect competitors, frequent changes in suppliers, legal regulations, and growth of businesses. Due to the limitation of objective data measures (i.e. industry growth rate, sales, total employment), we used subjective measures to measure

organisational munificence (α=0.88). The four-item scale adopted from Li et al. (2013) assesses the degree of growth opportunities provided by the UK market environment.

4.5 Control variables

This study includes control variables in the form of industrial characteristics to regulate their potential impact on the degree of perceived environmental characteristics and IT performance (Halperin and Chakrabarti, 1987). Industrial characteristics, including competitiveness, regulation, clock speed, etc. (Devaraj and Kohli, 2003), may shape the way in which IT is applied to focal firms to generate business value. Accordingly, three dummy variables for the industry type were included. Industry 1 was coded zero if the firms were service firms, or one if the firms were manufacturing firms. Industry 2 was coded zero if the firms were capital intensive, or one if the firms faced capital constraints. Finally, Industry 3 was coded zero for the medical instrument industry, and one for the electronic industry to regulate the influence due to the differences in the scope of the analysed industries (Augusto and Coelho, 2009).

4.6 Common method bias

A Harman one-factor test and confirmatory factor analysis serve to assess the potential for common method bias in the data (Podsakoff et al., 2003). An un-rotated factor analysis, using the eigenvalue-greater-than-one criterion, results in a solution that accounts for 68 per cent of the total variance, and the first factor accounts for only 31 per cent of the variance. Moreover, the CFA analysis revealed that the single-factor model did not fit the data well (χ^2/df=18.94, Goodness of Fit Index (GFI)=0.75, Comparative Fit Index (CFI)=0.85, Root Mean Square of Approximation (RMSEA)=0.11, Standardised Root Mean Square Residual (SRMR)=0.10). Moreover, we followed the approach recommended by Lindell and Whitney (2001) to detect the potential common method bias using a marker variable. The marker variable was the respondents' educational level, which revealed the lowest correlation with our key dependent variable. Using the marker variable in our analysis did not affect the significance levels of the

regression results. Thus, this indicates that the common method bias was effectively controlled in our analysis and is unlikely to be a serious concern in this study.

5. Analysis and results

5.1 Reliability and validity

We assessed the construct validity of all items pertaining to our constructs through exploratory and confirmatory factor analysis (CFA). Exploratory factor analysis of dependent, independent and moderating variable items clearly replicated the intended five-factor structure. All items loaded clearly on their intended factor with eigenvalues greater than one, supporting the five-factor solution. The CFA on all items revealed the good model fit (x^2/df=2.14, GFI=0.89, CFI=0.94, SRMR=0.04, RMSEA= 0.06). Table 2 shows the Cronbach's alpha and items loadings for each construct. The item loadings, Cronbach's alpha and composite reliability values are above the minimum cut-off value of 0.70, suggesting good internal consistency and reliability (Peterson and Kim, 2013). The square root values of average variance extracted (AVE) of each construct, diagonal values in Table 2, are higher than correlation values of the construct with other latent variables, thus exhibiting good discriminant validity among constructs.

5.2 Descriptive statistics and correlations

Table 3 reports the descriptive statistics, correlations and AVE of all construct variables. None of the inter-factor correlations is above 0.65, suggesting that our estimates are not likely to be biased by multi-collinearity problems. Moreover, we calculated variance inflation factors (VIFs) for each of the regression equations. The maximum VIF within the models was well below the cut-off value of 3 (Hair Jr, 2006).

		Mean	Std. Dev.	1	2	3	4	5	6	7	8
1	IT ambidexterity	7.18	2.05	**0.81**							
2	IT performance	4.03	0.75	0.34	**0.81**						
3	Ln firm size	4.13	1.02	0.44	0.14	**0.79**					
4	Ln firm age	2.58	1.07	0.06	0.02	0.37	**0.74**				
5	Environmental uncertainty	3.70	0.98	0.70	0.30	0.33	0.00	**0.84**			
6	Environmental complexity	3.21	1.11	0.54	0.17	0.38	0.05	0.62	**0.85**		
7	Environmental munificence	3.60	0.90	0.55	0.46	0.35	0.01	0.58	0.51	**0.78**	
8	Respondent education	2.03	0.85	0.13	0.01	0.26	0.12	0.08	0.09	0.04	-

Table 3: Means and correlations matrix; diagonal values represent the square root of AVE

5.3 Hypothesis testing

Table 4 provides the hierarchical moderated regression analysis results for all hypotheses. This table provides an individual and combined effect of all internal and external contingencies. The baseline model, Model 1, contains control variables. Model 2 presents the direct effect of IT ambidexterity on IT performance. Model 3 and Model 4 introduce the direct effect of internal contingencies and external contingencies, respectively. Model 5 and Model 6 present the moderating effects of internal contingency variables, whereas Model 7, Model 8 and Model 9 show the moderating effect of each external contingency factor. Model 10 indicates the collective moderating effects of all the internal and external contingencies factors on IT ambidexterity-IT performance link.

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
IT ambidexterity (ITA)		0.140***	0.141***	0.0739**	0.169***	0.142***	0.117***	0.164***	0.0698***	0.106***
		(0.0237)	(0.0241)	(0.0294)	(0.0245)	(0.0242)	(0.0300)	(0.0264)	(0.0248)	(0.0300)
Internal Contingencies										
Firm Size			0.0186							
			(0.161)							
Firm Age			0.0114							
			(0.0413)							
External Contingencies										
Uncertainty				0.0228						
				(0.0597)						
Complexity				-0.0995**						
				(0.0449)						
Munificence				0.373***						
				(0.0536)						
Moderations										
Firm size					-0.0704					-0.0422
					(0.159)					(0.147)
ITA * Firm size					0.184***					0.0815
					(0.0489)					(0.0539)
Firm age						0.0130				0.0462
						(0.0414)				(0.0377)
ITA * Firm age						0.0278				-0.0222
						(0.0442)				(0.0438)
Uncertainty							0.171***			0.0973
							(0.0573)			(0.0611)
ITA * Uncertainty							0.167***			0.0890*
							(0.0360)			(0.0514)

Complexity								-0.0175		-0.116***
								(0.0430)		(0.0442)
ITA * Complexity								0.143***		0.0850*
								(0.0364)		(0.0478)
Munificence									0.353***	0.333***
									(0.0497)	(0.0540)
ITA * Munificence									0.0882**	-0.0312
									(0.0344)	(0.0466)
Controls										
SME	0.220**	-0.0187	-0.0344	-0.0645	0.0570	-0.0367	-0.0536	-0.0460	-0.123	-0.0759
	(0.0850)	(0.0904)	(0.333)	(0.0861)	(0.324)	(0.0997)	(0.0875)	(0.0906)	(0.0848)	(0.305)
Industry 1	-0.0987	-0.0653	-0.0657	-0.0697	-0.0631	-0.0641	-0.0915	-0.0813	-0.110	-0.0802
	(0.0846)	(0.0805)	(0.0809)	(0.0748)	(0.0790)	(0.0808)	(0.0779)	(0.0791)	(0.0754)	(0.0741)
Industry 2	-0.0255	-0.0822	-0.0845	-0.128*	-0.0815	-0.0870	-0.0780	-0.0546	-0.128*	-0.112
	(0.0857)	(0.0820)	(0.0829)	(0.0765)	(0.0804)	(0.0828)	(0.0795)	(0.0807)	(0.0761)	(0.0754)
Industry 3	0.0174	-0.0183	-0.0199	-0.0175	-0.0484	-0.0196	-0.0678	-0.0298	-0.0269	-0.0688
	(0.0851)	(0.0811)	(0.0818)	(0.0754)	(0.0800)	(0.0816)	(0.0789)	(0.0795)	(0.0750)	(0.0746)
Respondent Education	-0.0396	-0.0478	-0.0490	-0.0317	-0.0448	-0.0448	-0.0499	-0.0525	-0.0298	-0.0436
	(0.0509)	(0.0484)	(0.0488)	(0.0450)	(0.0477)	(0.0489)	(0.0467)	(0.0474)	(0.0448)	(0.0444)
R-squared	0.024	0.154	0.154	0.261	0.191	0.155	0.221	0.200	0.270	0.318
ΔR-squared					0.037*	0.001	0.067**	0.046*	0.116*	0.16*

Standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: Regression results (dependent variable: IT performance) (N = 292)

Regarding the direct effects of IT ambidexterity on IT performance, Model 2 shows that the coefficient is positive and significant (β=0.14, p<0.001). This finding supports hypothesis 1. Hypothesis 2a proposes the positive moderating effect of organisational size on the relationship between IT ambidexterity and IT performance. Model 5 indicates that the interaction term for organisational size and IT ambidexterity is positive and significant (β=0.18, p<0.01), providing support for hypothesis 2a. Hypothesis 2b suggests that organisational age would have a positive influence on the IT ambidexterity-IT performance relationship. Model 6 shows that the interaction term is non-significant (p>0.1); therefore, hypothesis 2b is not supported.

Hypothesis 3a intends to positively moderate the effects of environmental dynamism, which is supported in Model 7 with a positive and significant beta value of the interaction term (β=0.17, p<0.01). Hypothesis 3b proposes that the moderating influence of environmental complexity would support the relationship between IT ambidexterity and IT performance. Model 8 indicates a positive and significant beta value of interaction term (β=0.14, p<0.01), supporting hypothesis 3b. Finally, hypothesis 3c suggests a positive influence for environmental munificence, which is supported in Model 9 with a positive and significant beta value for the interaction term (β=0.09, p<0.05).

To facilitate the interpretation of the significant two-way interactions, we followed the procedrue of Aiken and West (1991) to depict simple slope coefficients in Figure 2.

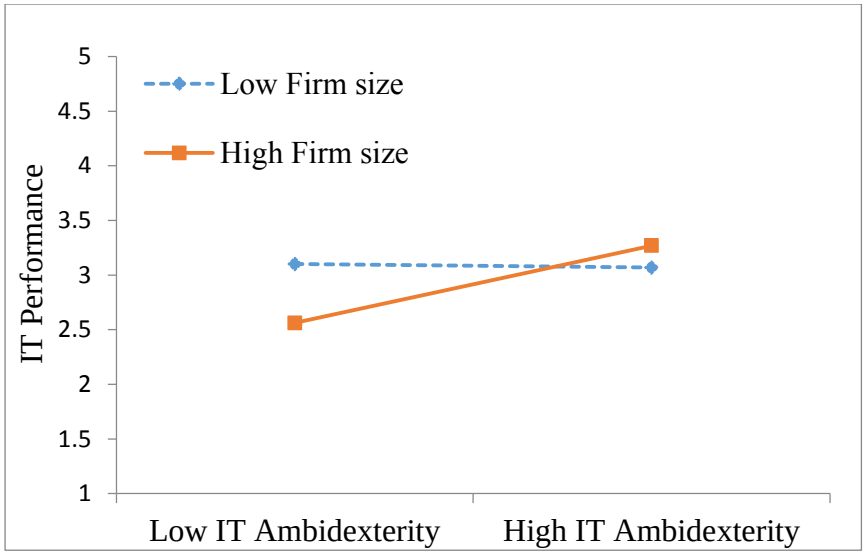

Figure 2(a). Moderating effect of firm size

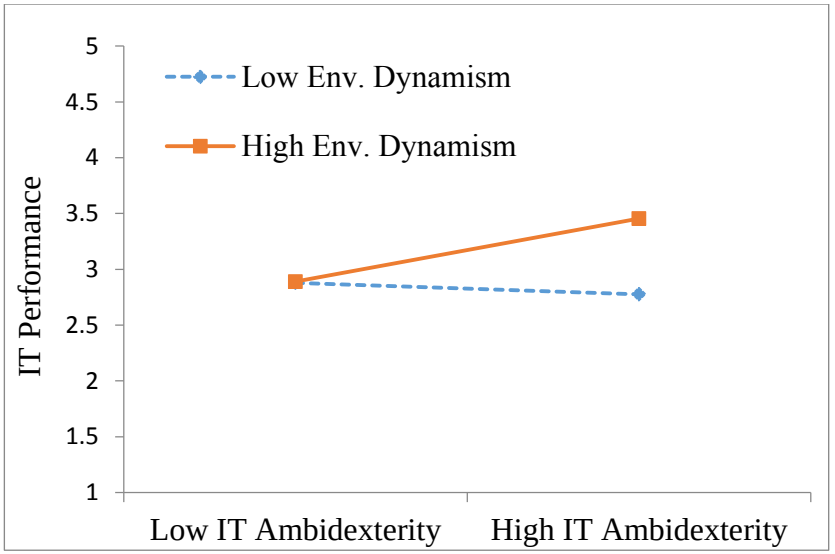

Figure 2(b). Moderating effect of environmental dynamism

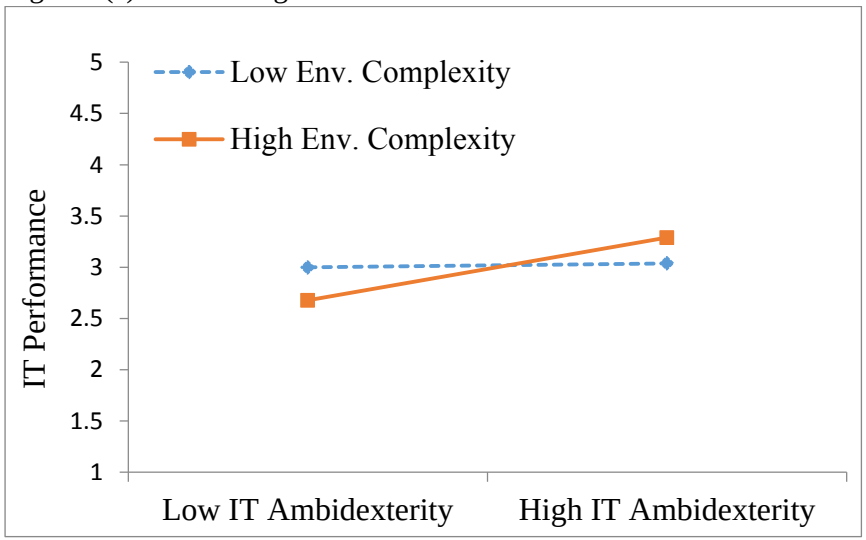

Figure 2(c). Moderating effect of environmental complexity

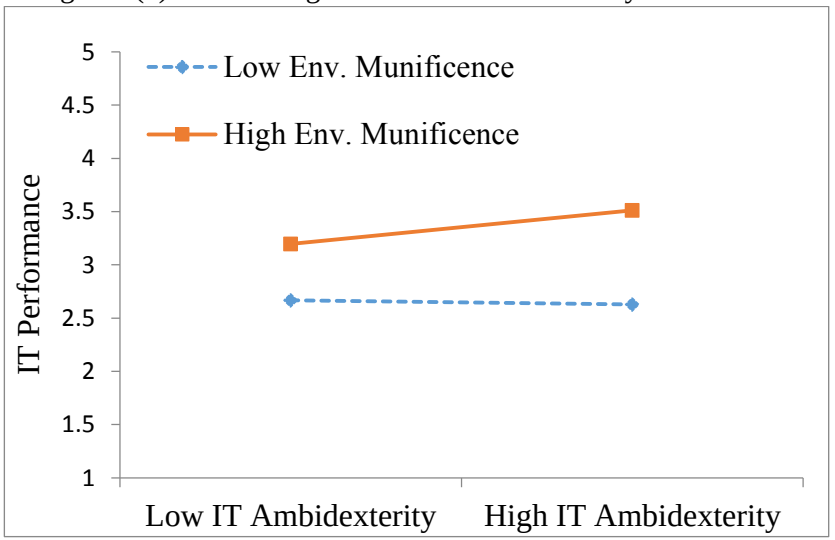

Figure 2(d). Moderating effect of environmental munificence

6. Discussion

The purpose of this study is to advance the IT ambidexterity literature by highlighting the influence of IT ambidexterity on IT performance. Moreover, it intends to identify the moderating effects of organisational internal and external contingencies on the relationship between IT ambidexterity and IT performance. The results of regression analysis reveal that, as expected, IT ambidexterity tends to enhance IT performance. This corresponds to the positive impact of IT ambidexterity found in other studies e.g. better revenues (Mithas and Rust, 2016), and higher supply chain competitiveness (Subramani, 2004). This finding also validates conceptual arguments by Gregory et al. (2015) that IT ambidexterity can enhance the performance output of organisational IT resources, thus signifying the role of IT ambidexterity as an organisational operant resource for competitiveness.

Table 3 shows the increase in R^2 between Model 2 and Model 5 is 0.04 and it is statistically significant (p<0.1). A similar rise in R^2 value is observed between Model 2 and Model 7, and Model 8 and Model 9, which indicates that the addition of the moderating variable (interaction term) significantly increases the explanation of variance in the dependent variable. Except for Model 6, the increase in R^2 is not significant (p>0.1), concluding that the interaction term did not contribute significantly to the fit of the model.

Model 5 and Model 6 in Table 3 show the moderating effects of internal contingencies on IT ambidexterity to IT performance link. The results show that organisational size aids the positive influence of IT ambidexterity on IT performance and provides further credence to previous studies (Voss and Voss, 2013; Cao et al., 2009), suggesting that organisational size enhances the performance outputs of a balanced ambidextrous orientation. This, thus, validates the argument of March (1991) and Lubatkin et al. (2006) that ambidexterity success is contingent on the availability of slack resources. Concerning the moderating effects of

organisational age, although a number of studies suggest a positive or negative relationship between age and innovation (Coad et al., 2016; Loderer and Waelchli, 2010), this study reveals insignificant moderating effects of firm age on IT ambidexterity. This finding contrasts with that of Voss and Voss (2013) study where they found a positive moderating effect of firm age on the relationship between product ambidexterity and market ambidexterity with revenues in SMEs in the United States (US). The difference in the findings of these studies can be explained by taking into account the scope of sample industries. For example, the choice of industrial context: their research sample compromises of non-profit professional theatres in the US, while our sample firms constitute high-tech SMEs in the UK. In contrast to the theatre industry (plays production and performance i.e. minstrels shows), the high-tech SMEs compete and survive by exploiting the robust performance outputs of their technological resources (Parker and Castleman, 2007); thus, old firm age may become inessential to realising the performance effects of IT capabilities. For instance, Yildiz et al. (2013), in their study of technological investment on innovation, found insignificant effects of organisational age on innovation. Moreover, the dependent variable for their study is firm revenues, that in the theatre industry may directly depend upon the reputation built through the years in the business. In contrast, IT performance in high-tech industries may not necessarily depend upon such factors. Such differences in the scope of the analysed industries might affect the results because some industries may not be sensitive to contingencies (Augusto and Coelho, 2009).

The moderating effect of external contingencies on the IT ambidexterity-IT performance relationship is positive and significant, as expected. In particular, Figure 2(b) indicates that environmental dynamism enhances the positive impact of IT ambidexterity on IT performance. This finding supports previous research findings and arguments that simultaneous pursuit in turbulent environments results in more competition for firms (Caspin-

Wagner et al., 2012). Environmental dynamism may provide a favourable opportunity for use of IT exploitation and IT exploration (Walia and Haried, 2007). For example, stable environments may allow firms to gain efficiency from IT exploitation, whereas in unstable environments firms may gain a competitive advantage by IT exploration as the new opportunities arise. Figure 2(c) shows that the higher environmental complexity increases the positive relationship between IT ambidexterity and IT performance. This finding is in accordance with the results found in previous empirical studies. For example, Revilla et al. (2010) find that in environments with high levels of complexity and dynamism, firms can improve product development efforts with an ambidextrous posture. This result also supports the arguments of Keen (1991), that complex environment may enhance the role of IT strategy (IT ambidexterity in this context) to simplify work procedures, coordination, decision-making and communication. Similarly, this supports the Simsek (2009) argument that in contrast to the simplistic strategic approach (one way of doing business), the ambidextrous strategy can lead to increased performance in complex environments. Finally, Figure 2(d) displays the amplified impacts of IT ambidexterity on IT performance in a munificent environment. This corresponds to the findings of almost every empirical study that evaluates moderating the impact of environmental munificence i.e. (Kyriakopoulos and Moorman, 2004; Venkatraman et al., 2007; Raisch and Hotz, 2010) and validates Dess and Beard (1984) conceptual argument that a munificence environment will support performance outputs irrespective of strategy.

Although the direct relationships between internal contingencies and external contingencies with IT performance were not hypothesised, our results of these relationships are consistent with that reported in the literature (Voss and Voss, 2013; Cao et al., 2009; Loderer and Waelchli, 2010; Walia and Haried, 2007; Venkatraman et al., 2007).

6.1 Theoretical implications

Our study makes several critical contributions to IS literature. First, it is one of the early studies to conceptualise ambidexterity in the IT context, thus responding to the endorsement of scholars to further understand the role of IT ambidexterity (Mithas and Rust, 2016). This study also advances existing knowledge by providing evidence that the simultaneous pursuit of IT exploitation and IT exploration significantly enhances IT performance. The results of this study reinforce the prior IS research that argues to maintain a balanced approach in the simultaneous pursuit of explorative and exploitative IT activities (Heckmann, 2015; Mithas and Rust, 2016; Subramani, 2004). Moreover, building on the contingency perspective of RBV, this study highlights the role of internal and external organisational conditions that influence the strength of the relationship between IT ambidexterity and IT performance. Interestingly, the results indicate that the performance realisation of IT ambidexterity may not depend upon whether firm is new or old. Irrespective of firm age, IT ambidexterity can be as advantageous for new entrants as it would be for incumbent firms. However, the higher levels of available resources, environmental dynamism, environmental complexity and environmental munificence would enhance the positive effects of IT ambidexterity in IT performance. In other words, IT ambidexterity plays a crucial role in supporting organisations to thrive within high level of environmental uncertainty. Thus, extending support to the contingent RBV perspective (Tsai and Yang, 2013) to highlight that the value of firms' strategic resource may be contingent on internal or external conditions.

6.2 Managerial Implications

Our study provides some guidelines for managers that have to contend with constant and accelerating waves of change, much of which are driven by advances in IT and e-business strategies. In contrast to previous beliefs that managers should exploit IT capabilities in stable environments and switch to exploration in unstable environments (Venkatraman et al., 2007),

our results suggest the need to balance the simultaneous pursuit of IT exploration and IT exploitation. The capability of IT ambidexterity can enhance the performance outputs of IT capabilities in high-tech SMEs. Moreover, the importance of IT ambidexterity would amplify in uncertain environments. Our findings caution managers that the performance implications of the IT ambidexterity may not depend upon the firm age, which means that the new entrant firms may as well realise the same performance outputs as the incumbent firms. However, the performance implications would enhance if the firm have more resources. Hence, managers, policy makers and consultants should be concerned about the available resources, instead of firm age, when seeking to benefit from the IT ambidexterity posture in high-tech SMEs. Finally, this study highlights the need to take into account both internal and external factors while implementing IT strategies.

6.3 Limitations and directions for future research

The limitations of this study that provide opportunities for future research are as follows: the use of self-reported data by single key informants may have limited the inferences among construct variables due to common method variance. Although self-reported data may not essentially be flawed (Tsai and Yang, 2013), future research could survey multiple informants to collect independent and dependent variables data separately, providing better methodological reliability (Jansen et al., 2006). Moreover, this research takes into account organisational and environmental factors as contingency variables; future research may also consider competitive market factors i.e. market rivalry (De Clercq et al., 2013), and market positioning (Hoque and James, 2000), that may as well pose threats to the success of the IT ambidexterity-IT performance relationship. Our empirical study includes subjective measures for collecting performance data over the past three years; future studies may benefit from gathering objective performance data that span over a longer period. The longitudinal data would enable in-depth performance implications by comparing the performance effects at

different points in time. Finally, our sample's industrial and geographically homogeneity limits the extent to which the results may be generalised, as our sample was composed of small and medium high-tech industries only in UK. Future research can examine whether these findings hold across large firms competing in non-high-tech industries in other countries. We hope that researchers will utilise and further refine and extend the findings of this study to ultimately contribute to a better theory of IT ambidexterity.

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CHAPTER 5

Chapter 5 | Joining forces to accelerate speed to market in high-tech SMEs: Insights from a mediation model

Abstract

This chapter furthers the investigation of previous chapter on the impacts of IT ambidexterity on performance outcomes, particularly focusing on the capability-building perspective of IT ambidexterity.

Speed to market is becoming an important weapon for high-tech SMEs to gain market shares in today's competitive, fast-changing consumer preferences and complex market environments. Drawing on the theory of IT-enabled organisational capabilities perspective, this study proposes that IT ambidexterity enhances speed to market by facilitating operational agility. We examine the proposed relationship with the potential moderating roles of formalisation and environmental complexity on a sample composed of 292 high-tech SMEs in the United Kingdom. The empirical analysis suggests that the effect of IT ambidexterity on speed to market is partially mediated by operational agility and the operational agility has a greater impact on speed to market in environments that are more complex. While formalisation does not moderate the link between IT ambidexterity and operational agility, our results reveal that this moderation effect is evident and significant in complex environments.

Key words: IT ambidexterity, operational agility, speed to market, formalisation, high-tech SMEs

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1. Introduction

> "Secrecy and speed were found to be more important than patents for firm competitiveness in some cases, but not all." (Holgersson, 2013: 30)

An increased speed to market is generating a better competitive advantage for firms in the high-tech industry, especially due to short product life cycles and high imitation risks (Holgersson, 2013). Speed to market reflects the time elapsed between product definition and product availability (Vesey, 1991). It capitalizes on first mover advantage and gains higher profitability through high market shares, premium prices, higher customer loyalty and increased resource efficiency (Feng et al., 2012; Perols et al., 2013). The economic turbulence and globalization of markets in recent years have defied firms to remain competitive when there is growing number of firms chasing dwindling number of orders from customers. An increasing number of firms rely on the strategy of rapid introduction of new products to grasp market share and increase profit (Holgersson, 2013). Therefore, it is of utmost importance to identify the mechanisms that can allow firms to accelerate their speed to market of new products.

The role of strategic management of organisational IT resources and technological advances in enhancing speed to market of new product development (NPD) processes has been recognised by both researchers (i.e., Pavlou and El Sawy, 2006; DeGroote and Marx, 2013; Perols et al., 2013) and practitioners. Companies such as Dell, United Parcel Service, and Cisco Systems have reduced the speed to market by successfully developing integrated supply chain systems with real-time information transmission between suppliers, manufacturers and customers (Rai et al., 2006). The recent advances in technological solutions have identified IT ambidexterity capability to enhance firm's ability in responding to market changes (Lee et al., 2015). IT ambidexterity refers to the ability of the firm to refine

their existing technologies (IT exploitation) and search new technological solutions (IT exploration) simultaneously (Lee et al., 2015). Particularly, IT ambidexterity capability can be highly desirable for small firms that may not afford to invest in huge separate units where they independently focus on exploration and exploitation.

Although prior Information Systems (IS) literature has emphasized the critical role of IT capabilities in enhancing speed to market for NPD, there are two gaps in the extant literature. First, prior studies view IT as a valuable and a distinctive organisational resource that can lead to increased speed to market (Barczak et al., 2008; Acur et al., 2010; Perols et al., 2013). However, the intermediating capability-building mechanisms have seldom been examined that enable IT to translate into these competitive manoeuvres. For instance, prior studies have examined certain direct, integrative and complementary relationships of IT tools that leads to enhanced speed to market, such as the influence of IT tools usage on speed (Barczak et al., 2008), integrating IT in supply chain operations to enhance speed (Attaran, 2004; Cotteleer and Bendoly, 2006), and the complementary impacts of IT assets on customer orientation to reduce speed to market (Feng et al., 2012). The missing link, how IT capabilities deliver enhanced speed through organisational capability-building processes, needs further understanding. Second, although some studies have articulated the criticality of organisational approaches for both IT exploitation and exploration (e.g., Lee et al., 2015; Mithas and Rust, 2016; Chi et al., 2017), the extant literature has seldom examined IT ambidexterity to enhance speed to market. Instead, prior research has focused on general latent capabilities of IT resources e.g., IT assets, IT investments and IT infrastructure (Barczak et al., 2007; Acur et al., 2010) to drive speed to market, the extant literature never explicitly conceptualized or tested IT ambidexterity in this context.

Firms tend to enhance their speed to market by implementing IT capabilities supported by formal structural mechanisms for NPD processes (Barczak et al., 2008). A formal

organisational structure (in short, organisational formalisation) is defined as the extent to which defined rules, established policies and standardized procedures regulate the day-to-day operations (Deshpande and Zaltman, 1982; Hempel et al., 2012). Formalisation brings minimal redundancy of tasks, removes double standards, regulates behaviours and increases the IT usage in production processes (Barczak et al., 2008). A plethora of studies in IS literature has identified that formalisation supports firms to align and implement their IT capabilities in delivering business objectives (e.g., Sabherwal and Chan, 2001; Gulati and Puranam, 2009; Ravishankar et al., 2011). Thus, the incorporation of formalisation in firms may complement the relationship between IT ambidexterity and speed to market – the core objective of this study. On a contrary, formalisation may hamper ad-hoc problem-solving efforts and reduce the likelihood of individuals deviating from structured behaviour, which may cease implementing innovative changes in product development processes (Kessler and Chakrabarti, 1996; Lukas et al., 2002). Either way, formalisation is an important factor that needs to be theoretically developed and empirically tested in our investigation.

To relieve the pressures of market rivalry, firms expand in global markets and tend to provide differentiated products through venture capitals (Clarysse et al., 2011). Such growth paths develop interdependencies among the firm actions that may affect the underlying IT-enabled mechanisms in delivering speed. Thus, we also examine the effect of environmental complexity on the underlying mechanisms for IT-enabled speed to market creation. Environmental complexity is defined as the extent of interdependences among firm decisions or actions (Dess and Beard, 1984), ranging from simple to highly complex environments. Firms facing a more complex environment will perceive greater uncertainty and have greater information processing requirements than the firms operating within a simpler environment (Stoel and Muhanna, 2009). The influence of environmental complexity becomes crucial for firms that intend to deliver speed and, therefore, is included in our investigation.

The goal of this study is to address the aforementioned research gaps by answering three key research questions: (1) how does IT ambidexterity effect speed to market within a firm? (2) Would the relationship between IT ambidexterity and an IT-enabled mechanism to enhance speed be strengthened in the firms that are formalised? and (3) whether environmental complexity influences the role of IT-enabled mechanism in delivering speed to market? To answer the first question we posit that IT ambidexterity develops operational agility (Sambamurthy et al., 2003), the ability to detect the change and rapidly redesign operations in the firm, as an important intermediating capability to deliver speed. Thus, we argue that IT ambidexterity enhances speed to market because it facilitates operational agility. We examine the potential moderating role of formalisation on the relationship between IT ambidexterity and operational agility, and the potential moderating role of environmental complexity on the relationship between operational agility and speed to market to address second and third research questions respectively. This study theorizes that IT ambidexterity enables operational agility to enhance speed to market, and that formalisation and environmental complexity perform roles of moderators in this equation. We test our theory using partial least square (PLS) path modelling, a structural equation modeling (SEM) technique, with a survey-based dataset on a sample of 292 high-tech small and medium enterprises (SMEs) in the United Kingdom (UK).

This study contributes to IS research by revealing a more comprehensive underlying mechanism between IT ambidexterity and speed to market. This study highlights the idiosyncratic role of formalisation to complement IT capability in developing organisational capabilities under varying environmental complexity conditions. Finally, we contribute to the literature on speed to market in high-tech SMEs, investigating a new combination of antecedents that have been recently discussed, but not in the context of NPD. The resulting

theoretical arguments and empirical evidence can yield further insights into the strategic impacts of IT.

The remainder of the paper is organised as follows. In the next section, we provide a literature review and describe the development of our theoretical perspectives, followed by the study's hypotheses. Subsequently, we present the details of our data gathering methodology, empirical analysis, and results. Finally, we discuss the implications of this study for future research and practice.

2. Theoretical background and literature review

This study draws on ambidexterity and IT-enabled organisational capabilities perspectives to conceptualize our theoretical model. The elements of conceptual development are described in the following sections.

2.1. Organisational ambidexterity and IT ambidexterity

Ambidexterity represents the ability of the person to work with both hands with equal ease. This concept is increasingly being used in organisations to represent the ability of the firm to balance differing and often competing trade-off situations. Organisational learning theorists identify these two distinct trade-offs as exploitation and exploration for organisations to leverage their resources and capabilities (March, 1991; Levinthal and March, 1993). Exploitation refers to the efficiency, refinement, and enhancement of existing organisational resources through known processes, whereas, exploration relates to searching, experimenting and innovating potential resources to create new capabilities and opportunities (March, 1991). Ambidexterity reflects the synergistic effect of pursuing both activities simultaneously (He and Wong, 2004; Gibson and Birkinshaw, 2004). To pursue exploration and exploitation in a balanced way so that they complement each other is highly desirable for firms to sustain a long-term competitive advantage (Raisch et al., 2009).

The same concept has steadily expanded in IS research, defining IT ambidexterity as the ability of the firm to undertake exploitation and exploration of IT resources and practices (Lee et al., 2015; Mithas and Rust, 2016). IT exploitation refers to the continuous improvement of existing technological practices, whereas, IT exploration is associated with introducing novel and innovative technological solutions (Lee et al., 2015). Although prior research highlights the role of IT ambidexterity in enabling organisational agility (Lee et al., 2015) and enhancing operational performance (Mithas and Rust, 2016), the role of IT ambidexterity has not been examined in NPD context. Particularly in high-tech firms, where an accelerated speed to market represents the success of new products development process (Chandrasekaran et al., 2012; Holgersson, 2013), therefore, this study analyses the impact of IT ambidexterity in accelerating speed to market of new products.

2.2. IT ambidexterity and speed to market

Prior IS literature has focused primarily on the effects of IT on enhancing the operational and process efficiency in NPD processes (i.e., Cotteleer and Bendoly, 2006; Pavlou and El Sawy, 2006; Acur et al., 2010), however, literature reports a mixed result for the findings of the impact of IT on speed to market. For example, Pavlou and El Sawy (2006) measure speed to market as a process efficiency indicator in NPD and found a positive relationship between IT-enabled NPD activities and process efficiency. Whereas, Barczak et al. (2007) report the insignificant impact of IT usage on speed to market in the USA and Canadian firms. Later, they found IT usage to significantly impact speed to market in Netherlands firms (Barczak et al., 2008). The inconsistencies among the results suggest a thorough investigation on the intermediating mechanism in this relationship.

Acur et al. (2010) identify that firm's technological competence (i.e., ability to seize and reconfigure IT resources) enhances speed to market, whereas, technological alignment has negative effects on speed. Acur and his colleagues work is intriguing because it shows that

the two varied, but necessary, traits of IT activities lead to opposing outcomes in a firm. However, Acur's work leaves an open question of what will be the impact on speed to market in the firms that are able to apply a balanced approach (IT ambidexterity) in such opposing IT activities. Given these competing perspectives and the absence of empirical research to resolve this dispute, the current study seeks to determine whether in fact IT ambidexterity helps or hurts speed to market. This study differs from the prior research, first, by focusing on IT ambidexterity, and, secondly, it highlights the intermediating IT-enabled organisational capability that allows firms to leverage their IT resources in enhancing speed. Table 1 provides a comprehensive analysis of the prior literature on the impact of IT on speed to market.

Author	Context/Research focus	Theoretical lens	Methodology	Key arguments and findings
Attaran (2004)	Influence of IT on business process re-engineering	Strategic IT integration	Theoretical development	IT assists firms to initiate and sustain business process re-engineering as an enabler before process design, facilitator during process design, and implementer after process design. It assists positively in reducing the average operational cycle time for firms.
Pavlou and El Sawy (2006)[a]	Influence of IT functionalities on NPD competitive advantage through dynamic and functional competencies	IT leveraging competence	Empirical analysis using field survey of 180 NPD managers	IT functionalities (project and resource management systems, knowledge management systems and cooperative work systems) build a higher order construct of IT leveraging competence, which is fully mediated by dynamic and NPD functional capabilities to enhance competitive advantage in NPD. This influence is more

				pronounced in turbulent environments.
Cotteleer and Bendoly (2006)	Influence of IT implementation on order lead-time improvement (operational performance)	Swift, even flow	Case examination and empirical analysis using longitudinal data of a firm	The IT implementation systems (e.g., enterprise resource planning) results in an improved operational performance (e.g., order fulfilment lead time). The ongoing learning effects (e.g., continuing improvements in order fulfilment lead time) are found observable and significant over an extended period after deployment.
Barczak et al. (2008)	Antecedents and influence of IT tools usage on NPD performance	Hofstede's theory of culture to compare antecedents and performance across US and Netherlands	Empirical analysis using field survey of 212 US Product Development & Management Association's practitioner members and 118 Dutch NPD managers	In the United States, IT embeddedness, NPD process formalisation, and outsourcing of NPD projects positively influence IT usage. In the Netherlands, IT embeddedness and NPD process formalisation have a positive impact on IT usage, while, colocation and length of time on the job are negatively associated with IT usage. Finally, IT usage positively influences speed to market in the Netherlands and market performance in the United States.
Acur et al. (2010)	Influence of technological competence development on NPD performance and speed to market	Dynamic capabilities approach	Empirical analysis using field survey of 164 firms	Technological alignment (the extent to which technological developments guide a firm's NPD activities) was negatively related, whereas, technological competence development (ability to acquire, integrate, and reconfigure technological knowledge) was positively affecting speed.

DeGroote and Marx (2013)	Influence of IT on supply chain agility and firm performance	Capability building perspective	Empirical analysis using field survey of 193 US manufacturing firms	IT develops supply chain's ability to sense and respond to market changes. The enhanced supply chain agility has positive impacts on the firm's sales, market share, profitability, speed to market, and customer satisfaction.
Perols et al. (2013)	Influence of supplier integration on speed to market and mediating role of external Technology.	IT adoption and assimilation	Empirical analysis using field survey of 116 US firms in industrials, healthcare, and IT industries	External technology adoption partially mediates the relationship between supplier integration and speed to market. There is a synergistic effect between external technology adoption and internal exploration activities, such that firms with high internal exploration activities, external technology adoption accelerate time-to-market and firms with low internal exploration activities, external technology adoption decelerates time-to-market.

Table 1: Comprehensive overview of the research on the IT influence on speed to market

2.3. IT-enabled organisational capability for speed to market

IT-enabled organisational capabilities perspective argues that IT enables intermediating organisational capabilities to generate value for the firm. Consistent with this conceptualization, IS researchers have examined the IT-enabled organisational capabilities, such as social media competence (Braojos-Gomez et al., 2015), operational ambidexterity (Lee et al., 2015), knowledge ambidexterity (Benitez et al., 2017) etc., that help firms to develop novel competitive actions. However, our understanding of how IT ambidexterity translates into delivering speed to market through IT-enabled organisational capabilities remains limited.

To address this theoretical gap, we focus on operational agility as a key IT-enabled organisational capability that allows the firm to enhance speed to market of new products. Operational agility, defined as the ability to rapidly detect and redesign existing processes to exploit dynamic marketplace opportunities quickly, accurately and cost-efficiently, is critical to achieving excellent speed to market as it depends on firm's reaction to market changes (Sambamurthy et al., 2003). For instance, the built-to-order operational model by Dell can be thought as an example of an agile operational capability that responds swiftly to the fast changing end-user preference. However, such constant reconfiguration of business operations requires technological support (Tallon, 2008; Benitez et al., 2018). Recognizing that operational agility is driven by technology, IS researchers have tended to conclude that a firm could strengthen it by leveraging its IT capability (Chen et al., 2014; Tan et al., 2017; Benitez et al., 2018). Particularly, for firms in high-tech or fashion industries where change is both expected and regular, IT ambidexterity has emerged, next to operational agility, an imperative to avoid rigidity traps of IT (Tallon, 2008). However, the literature on these areas have evolved separately, therefore, this study seeks to close the gap in understanding of how a dual pursuit of diversified IT activities leads to an enhanced speed to market by examining the mediating role of operational agility.

2.4. IT ambidexterity, formalisation and operational agility

The new era of globalized firms with proliferating IT tools is becoming increasingly aware of applying standardized practices to enhance the value of IT functionalities. Barczak et al. (2008), for example, asserts that firms can enhance IT tools usage by implementing formalisation. The research on the integration of business processes and IT capabilities have embarked on the strategic implementation of formalisation and alignment strategies that can translate into competitive frameworks (Gulati and Puranam, 2009; Tallon and Pinsonneault, 2011). For instance, the work of Ravishankar et al. (2011) highlights the influence of multi-

level organisational cultures on IS alignment and implementation success. Their work emphasizes criticality of organisational settings on IT implementation strategies, thus, we include the role of formalisation in our framework.

Formalisation can be supportive of firm strategies when it enables employees' mastery of their work and may negatively influence outcomes when it coerces employees into compliance (Adler and Borys, 1996). IT-supported learning and adaptation reinforced by formally structured organisational information flows can facilitate firm employees in reducing the time and effort involved in adjusting operations to changing business environment. For example, Gosain et al. (2004) provide a theory of coordination and assert that firms enrich their capability to adjust their operations and support change through standardizing interfaces, which establish technical grammar to reduce the amount of information exchange and facilitate coordination in the face of change. Such use of formalisation strategies can significantly reinforce IT capability in developing operational flexibility. However, there is a lack of adequate attention to this topic in IS research require further investigation (Ravishankar et al., 2011). Our paper attempts to fill this gap by analysing the moderator role of formalisation in IT ambidexterity and operational agility link.

3. Hypothesis development

3.1. IT ambidexterity, operational agility, and speed to market

The simultaneous pursuit of IT exploitation and IT exploration ensures the efficient use of existing technology to quickly access data across units at the same time strive to innovate technological practices for real-time market data to adjust firm actions accordingly (Lee et al., 2015; Mithas and Rust, 2016). For example, Haier Group started as an importer of refrigerator production technologies, leveraged IT exploitation and IT exploration both at the same time enabling operational agility that evolved Haier Group as a global appliance company with ninety-six product categories (Huang et al., 2012). Along with a continued

emphasis on improving existing technologies to digitize procurement and supply chain systems to catch up with the pace of Haier's fast expansion, Haier implemented an innovative Global Value System (GVS). GVS was able to achieve processes synchronization and check the alignment between requirements and constraints of different departments so that the outcomes of planning were accurate and feasible. This enhancement in the ability of operations to process information facilitated sensing market trends and in time responding to competitive actions, in turn, enabled firm to achieve superior operational manoeuvrability. Haier's ability to simultaneously undertake both IT exploration and IT exploitation had demonstrated to improve operational agility (Huang et al., 2012). Lack of appropriate IT management makes it difficult for firms to adjust to changing market conditions, resulting in non-reactive and slow responses when the firm seeks new strategies (Overby et al., 2006; Tallon and Pinsonneault, 2011). A simultaneous pursuit of internal integration, modification by improving existing systems, and evolving externally, integrating innovative practices, influences mobility, transformability, and flexibility in firm operations (Wei et al., 2014). For example, Zara, a leader in a world of fashion, consistently improves their operational agility through continuous improvement in existing technologies to collect real-time data at the same time investing in sophisticated IT systems to build shared situation awareness (making sense of real-time data from multiple sources) (Sull and Turconi, 2008). Therefore, IT ambidexterity facilitates firms to sense and respond to market conditions by developing operational agility.

In turn, this IT ambidexterity enabled operational agility allows firms to reconfigure existing processes rapidly to meet changing demands and win profit, market share and customers by accelerated speed to market of new products (Yusuf et al., 1999). Kumar and Motwani (1995) argue that operational agility induces the ability to accelerate the activities on the critical path and generate time-based competitiveness, thus making firms well

positioned to take advantage of speed, delivering new products ahead of competitors, and proactivity, making products available just before the need arises (Yusuf et al., 1999). For example, Dell consistently polishes its capability to respond to market changes by operational segmentation that has allowed it to gain competitiveness over Compaq and Hewlett-Packard (Magretta, 1998). In particular, firms in high-tech and fashion industries may largely rely upon market conditions and environmental changes, such as pricing move of suppliers, fluctuations in customer demand, the strategic move of large competitors or government policies (Oke et al., 2007). Under such uncertain market conditions, firms with operational capabilities to sense and respond to market orders may prove more successful (Overby et al., 2006; Tallon and Pinsonneault, 2011; Benitez et al., 2018). Consider the firms that have digitalized their operations with a continuous focus on IT exploitation and IT exploration are able to exercise higher agility and enhanced speed. For example, Alcoa with advanced aluminium investment casting has compressed prototyping time, and Fiat has reduced the physical prototypes slashing eight-month prototyping process to one week (George et al., 2014). Therefore, we hypothesize the following:

H1: IT ambidexterity accelerates the speed to market of new products by facilitating operational agility.

3.2. Moderating role of formalisation in the relationship between IT ambidexterity and operational agility

Formalisation in organisational processes induces minimal redundancy of tasks, removes double standards, regulates behaviours and encourages focus (Hempel et al., 2012). Scholars have used the metaphors of ‘red tape’ or ‘riverbank’ to elucidate the role of formalisation in highlighting the boundaries of autonomy in firm operations. For instance, formalisation represents the banks within which firms operate and act to delineate responsibilities, allows coordination among departments, clarify goals, procedures, and areas of responsibility and

provides direction to the firm (Blanchard et al., 2001). This investigation argues that the relationship between IT ambidexterity and operational agility can be stronger in the presence of organisational formalisation; that is, formalisation can perform a positive moderator role in this relationship.

The established routines and practices support firms to effectively manage IT tools and systems (e.g., computer-aided software engineering (CASE), capability maturity model (CMM), and enterprise resource planning (ERP) system) that attempt to improve control over technical and operational reconfiguration in the face of change and provide better outcomes in terms of time, cost and quality (Patnayakuni and Ruppel, 2006). The formalised organisation systems facilitate superior and faster information flows and stronger coordination both within the firm and with the supply chain members (Gosain et al., 2004). Such information flows and coordination by formalisation increases opportunities to leverage IT resources to sense changing market conditions and redesign operations within time. For example, Pal's Sudden Service, a fast food chain that successfully competes with McDonald's and Burger King, capitalizes on its formalised organisational processes with novel technologies designed to facilitate operational flexibility, accuracy, and errorless order delivery in about twenty seconds, compared to its rivals' rate of seventy five seconds (McDermott et al., 2003).

In summary, firms with formalisation can support and manage IT exploitation and exploration activities to reconfigure existing operations rapidly in meeting changing demands. Therefore, we expect that organisational formalisation will assist IT ambidexterity to enable operational agility.

H2: Organisational formalisation positively moderates the relationship between IT ambidexterity and operational agility.

3.3. Moderating role of environmental complexity in the relationship between operational agility and speed to market

Firms operate within external environments that often influence their strategies for and constraints on performance (Stoel and Muhanna, 2009). Thus, the IT-enabled operational agility may be contingent on a firm's environmental context. In particular, the large interdependencies among firm activities may compromise its tendency to deliver speed. Environmental complexity represents the heterogeneity of product offerings and the level of knowledge sophistication of the system that has multiple interdependencies (Dess and Beard, 1984). The environmental complexity or the level of interdependency increases as the firm grows i.e., increasing the number of suppliers, joint ventures, internationalization strategies or mergers and acquisitions (Stoel and Muhanna, 2009; Clarysse et al., 2011). We argue that the IT-enabled operational agility can be more effective in complex environments in delivering speed.

Lower levels of environmental complexity are characterised by stable and lower interdependencies. Firms that operate in such environments can produce homogeneous products and require low information processing (Chen et al., 2014). Under these conditions, firms can leverage more stabilized and well-developed practices (Stoel and Muhanna, 2009; Lee et al., 2015). On a contrary, in high levels of complexity, a firm will perceive greater uncertainty and have greater information processing requirements (Chen et al., 2014). Firms operation in such environments need to reconfigure their operational processes by applying complex and sophisticated knowledge, and coping with varied external stakeholders (such as suppliers, customers, and competitors) (Wade and Hulland, 2004). Under these environments, the operational agility might be more necessary for firms to adjust swiftly to changing business opportunities for competitive manoeuvres and are thus more likely to achieve higher speed to market.

In summary, firms with high levels of environmental complexity may benefit higher effects of operational agility on speed to market than the firms in simple environments with the likelihood of fewer opportunities to exercise operational agility. Based on this rationale, we formulate the following hypothesis:

H3: Environmental complexity will positively moderate the impact of operational agility on speed to market. Figure 1 presents the proposed conceptual model.

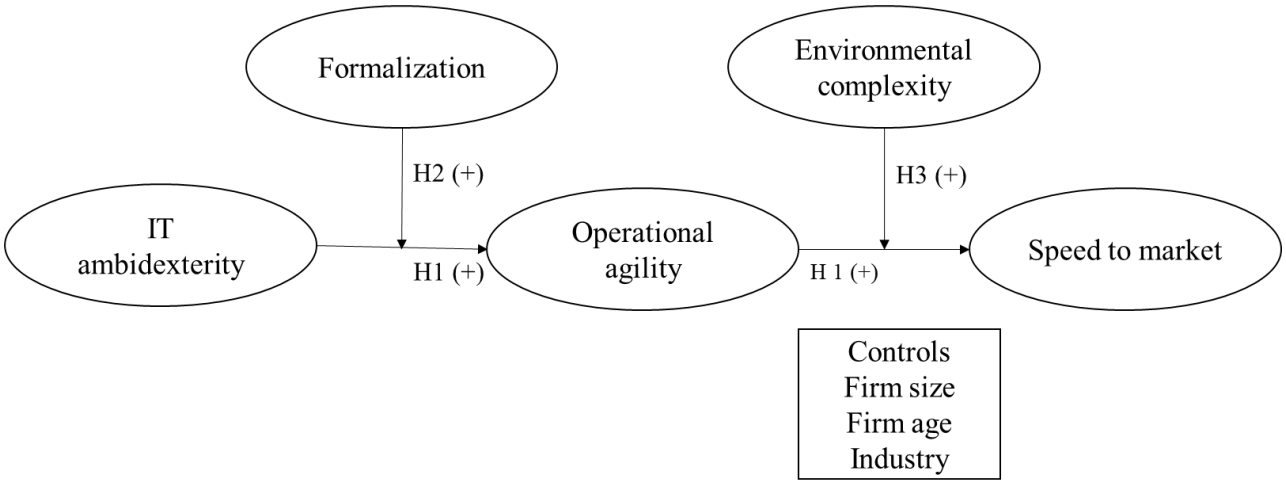

Figure 1: Conceptual model

4. Research methodology

4.1. Empirical context and data collection

The target sample for this study consisted of SMEs in the UK, which have been in operation for at least three years and operate in a high-tech industry, producing technologically sophisticated products and services. Our sample covers a range of high-tech SMEs involved in new products and services development projects – specifically, we included precision equipment manufacturers, computer and electronic product manufacturing, control instrument manufacturing, telecommunication, medical equipment and supplies manufacturing, and optics apparatus, all of which are included in NAICS 2012 industry classification under codes 33,51 and 54. Based on aforementioned criteria, our sample

consisted of 1000 high-tech UK SMEs complied from a published FAME database in the year 2015. FAME database provides the most comprehensive listing of UK companies and contact information that includes both listed and not listed firms on the London Stock Exchange.

High-tech is one of the most rapidly evolving sectors among SMEs (Oke et al., 2007; Holgersson, 2013). As British government reports that 13.4 percent of SMEs operate in high-tech sector with 74.7 percent share of employment and 65.7 percent share in turnover, which represents a quarter of all UK SMEs (Department for Business Innovation Skills, 2011). UK is, apart from USA and Taiwan, one of the most important supply centres of high-tech products in the world (Oke et al., 2007; Tsai and Yang, 2013). The economic significance of high-tech SMEs has been widely recognised nationally and internationally. Therefore, many governments have been taking initiatives to support the growth of this sector. In particular, the British Government has placed significant emphasis to promote the high-tech industry through initiatives like UK Investment Industry, The Tech City Investment Organisation, Global Innovation Program and Living Innovation (Department for Business Innovation Skills, 2011). Ranking 15th among the world innovation enablers in the 2009-2013 Innovation Index (Economist Intelligence Unit, 2009), UK high-tech SMEs provides a rich context to examine the speed to market of new products. Focusing particularly on high-tech SMEs may also contribute to reducing the potential variance caused by industry effect (Tsai and Yang, 2013), thus, allowing us to better investigate whether IT ambidexterity enables operational agility to accelerate the speed of new products and services.

We used a survey questionnaire as the data collection instrument to test our hypotheses. In an effort to improve content validity and response rates, the survey questionnaire was designed, formulated, and implemented in a manner which closely followed the recommendations of Podsakoff et al. (2003). After finalizing the questionnaire, the key

respondents (technical leaders, operational managers, and project managers) of the sample frame were contacted by a telephone call and an e-mail before sending them the link of an online questionnaire to the respondents who agreed to participate. Follow up was made with a telephone call and two reminder e-mails were sent to the non-respondents after three weeks. Upon removing the 25 unusable responses, 292 valid responses remained with complete information for the variables of interest representing 29.2 percent rate of response. Our final sample contains firms with a mean age of 22.28 (SD = 34.5) years and a mean size of 129 (SD = 90.2) full-time employees that operate in various industries covering computer and peripheral equipment (94 projects, 32.2 percent), communications equipment (47 projects, 16.1 percent), semiconductor and electronic components (78 projects, 26.7 percent), medical equipment and supplies (32 projects, 11 percent) and industrial and precision equipment (41 project, 14 percent).

In order to assess the nonresponse bias, we compared the patterns of respondents with non-respondents and early and late respondents for the final sample. Results of t-tests revealed that the respondents and non-respondents, also early and late respondents do not differ significantly ($p < 0.05$) in terms of firm size, firm age and industry type[13]. These analyses indicate that nonresponse bias is not a likely issue in our study.

4.2. Measures

All measures in the study were evaluated from the well-established scales in literature. Every attempt was made to use existing validated measures that have good psychometric properties, although we made some modifications to suit the context of our research. All items were based on five-point Likert scales with 1 indicating "strong disagreement" and 5 indicating "strong agreement" with the statements.

[13] The industry types were classified in to service firms and manufacturing firms based on the industry classification under NAICS 2012.

4.2.1. IT ambidexterity

IT ambidexterity represents the simultaneous approach of firms in pursuing IT exploitation and IT exploration activities and thus is measured as the combination of these activities. IT ambidexterity was operationalised as a second-order construct determined by the five-indicator composite[14] first-order construct of IT exploitation and a five-indicator composite first-order construct of IT exploration. IT exploitation was measured by adapting the scale that evaluates the competency of the firms to refine their existing IT systems quality, expanding existing IT services, and extending the current IT operations. IT exploration was measured by adapting the scale that captures the competency of the firm to introduce new technology applications, new informational services range, and introducing new IT practices when compared to its industry. The measures of IT exploitation and IT exploration were adapted from the studies of Lee et al. (2015) and Jansen et al. (2006).

4.2.2. Operational agility:

Operational agility was measured by a first order three-indicator composite construct. The three items scale reflects the ability of organisational internal processes to physically and rapidly cope with and respond to the change in market or customer requirements. The measuring scale was adopted from the study of Lu and Ramamurthy (2011).

4.2.3. Formalisation:

Organisational formalisation was assessed by a first-order three-indicator composite construct. Three indicators scale adapted from Hempel et al. (2012) measures the extent to which formalised procedures have been adopted within the organisation. Questions are asked about the use of written rule and procedures, cost controls and quality control procedures.

[14] Composite-formative (in short, composites) are usually behavioural constructs, consisting of components that are more elementary. These composites serve as representative for the concept under investigation and can be perceived as a mix of ingredients (indicators/dimensions) to create the recipe (composite) (Benitez et al., 2017; Benitez et al., 2018). This research operationalised all constructs as composites.

4.2.4. Environmental complexity:

The first-order four-indicator composite construct operationalised environmental complexity. The four items scale was adopted from the studies of Chen et al. (2014) and Hanisch and Wald (2014) that measures complexity in terms of the heterogeneity (diversity in customers' buying habits and product lines) of and range of an organisation's activities resulting from frequent change of suppliers and legal regulations.

4.2.5. Speed to market:

Since we used a multi-industry (manufacturing and service) sample, we tried to control for speed-to-market differences in the nature of projects by using relative speed measures. This approach and items content to measure speed to market were adopted from Akgün and Lynn (2002). The four items scale for assessing the speed to market of the new products or service introduction compared actual performance to pre-set schedules, company standards and similar competitive projects. The speed to market was assessed as a first-order four-indicator composite construct.

4.2.6. Control variables

We controlled for the effects of firm size, firm age, and industry on speed to market. Firm size was measured as the natural logarithm of the average number of full-time employees in the firm. Firm age was measured as the natural logarithm of the total number of years the firm had been in business. Industry variable was operationalised with a dummy variable of zero for manufacturing firms and one for service firms.

5. Empirical analysis and results

We performed PLS path modelling to test the developed hypotheses and to examine the mediation effects involved in our proposed model. The choice of PLS is appropriate for the estimation method for the following reasons. First, PLS is an optimal method to estimate

composite models (Benitez-Amado et al., 2017; Benitez et al., 2018). Second, the use of PLS has been recommended when theoretical knowledge about a topic is scarce (Petter et al., 2007). This study examines the IT ambidexterity enabled mechanisms to enhance speed to market of new products in high-tech SMEs. Insofar as our study covers a research problem that has not been examined in prior literature, it reveals the degree to which prior theory is limited and PLS estimation is appropriate. Third, PLS-SEM method provides better estimations of complex models with both second- and first-order level composite constructs (Braojos-Gomez et al., 2015; Hair et al., 2012). Finally, PLS does not impose any normality requirements on the data and tests for exact model fit (Henseler et al., 2016). We used the latest statistical tool Advanced Analysis for Composites (ADANCO) 2.0 Professional by Henseler and Dijkstra (2015). ADANCO is a contemporary variance-based SEM software that facilitates causal and predictive modelling (Benitez et al., 2017; Benitez et al., 2018).

5.1. Measurement model evaluation

The methods of evaluation for measurement and structural model may differ with respect to the nature of relationships (formative or reflective) between measures and constructs (Jarvis et al., 2003; Benitez-Amado et al., 2015). In formative constructs the indicators are considered to be the cause of the latent variable, whereas, in reflective constructs the indicators are considered to be caused by the latent variable (see Petter et al. (2007)). All the constructs in this study were characterised as formative constructs. Thus, we assess the psychometric properties of our first- and second-order composite constructs by content validity, multicollinearity, weights and loadings, since the traditional assessments of validity

and reliability (i.e., composite reliability, average variance extracted and Cronbach's alpha) may not apply well to formative constructs[15] (Petter et al., 2007).

We calculated the variance inflation factors (VIFs) at both first- and second-order levels to examine the multicollinearity. The VIFs higher than 10 indicate an issue of multicollinearity (Thatcher and Perrewe, 2002). Our results reveal the VIF scores range from 1.653 to 3.536, suggesting that multicollinearity is not a problem in our data.

We used a bootstrap analysis with 5000 subsamples, which is well recommended and commonly used in PLS analysis to estimate the significance of loadings, weights and path coefficients (Benitez-Amado et al., 2015; Benitez-Amado et al., 2017). The analyses reveal that all the indicator weights and loadings were significant except for the weight of one indicator of environmental complexity, EC3. This composite indicator was retained because of significant loading (Cenfetelli et al., 2009; Benitez et al., 2017). Table 2 displays the detailed properties of the measurement model.

Table 2: Measurement model evaluation at first- and second-order levels.

Construct/dimension/indicator	Mean	S.D.	VIF	Weight	Loading
IT ambidexterity (composite, mode B)	3.613	2.043			
IT exploration (composite, mode B)	3.589	1.861	3.536	0.439***	0.941***
IT exploitation (composite, mode B)	3.636	1.932	3.536	0.583***	0.989***
Operational agility (composite, mode B)	3.079	1.391			
OPA 1	2.891	0.826	1.723	0.234**	0.764***
OPA 2	3.102	1.839	1.785	0.349***	0.823***
OPA 3	3.234	1.241	1.653	0.548***	0.913***
Formalisation (composite, mode B)	3.406	2.103			
FOR 1	3.493	2.413	2.863	0.376***	0.954***
FOR 2	3.561	2.162	2.933	0.247*	0.825***
FOR 3	3.164	1.996	3.081	0.444***	0.925***
Environmental complexity (composite, mode B)	3.178	1.803			
EC 1	3.301	1.268	2.134	0.353***	0.871***
EC 2	2.937	1.968	2.174	0.316***	0.856***
EC 3	3.132	2.015	3.461	0.154	0.873***
EC 4	3.331	1.922	3.068	0.323***	0.885***
Speed to market (composite, mode B)	3.236	1.830			
STM 1	2.813	1.948	2.462	0.339***	0.928***
STM 2	3.412	0.902	2.645	0.247*	0.803***

[15] As a robustness check, we performed the traditional assessments of validity and reliability by measuring Cronbach's alpha, composite reliability and average variance extracted scores. The results, reported in Appendix C, suggest good psychometric properties of our constructs.

STM 3	3.114	2.021	3.222	0.246**	0.878***
STM 4	3.603	2.684	2.566	0.289**	0.847***
Firm size: Natural logarithm of the total number of full-time employees	4.162	1.851			
Firm age: Natural logarithm of the number of years of the firm's operations	1.451	0.598			
Industry: Manufacturing vs. service	0.438	0.500			
Note: *p < 0.05, **p < 0.01, ***p < 0.001					

Finally, the saturated model was tested for the external validity of all composites through a confirmatory composite analysis (Henseler et al., 2014; Benitez-Amado et al., 2017). Confirmatory composite analysis validates the appropriateness of the composite models by equating the empirical correlation matric with the model-inferred correlation matric of the saturated model. It also highlights the model misspecifications, in terms of a number of constructs or indicators assigned to constructs (Henseler et al., 2014). The results for confirmatory composite analysis indicate empirical support for this structure of composites at the first- and second-order levels based on an alpha level of 0.05 since all discrepancies are below the 95%-quantile of the bootstrap discrepancies. Table 3 shows the details of confirmatory composite analysis results for saturated models. The aforementioned analysis suggests that the proposed model has good measurement properties and can be processed with structural assessment for hypothesis testing.

Table 3: Results of confirmatory composite analysis (saturated model).

Discrepancy	**First-order level**			**Second-order level**		
	Value	HI_{95}	Conclusion	Value	HI_{95}	Conclusion
SRMR	0.031	0.033	Supported	0.012	0.019	Supported
d_{ULS}	0.337	0.391	Supported	0.003	0.005	Supported
d_G	0.272	0.315	Supported	0.007	0.010	Supported

5.2. Common method bias

To dampen the common method bias associated with the single means of data collection, we formulated the survey questionnaire following the procedural methods suggested by Podsakoff et al. (2003). The questionnaire was designed using different scale formats and

anchors for the key variables. Moreover, the anonymity of the responses was assured to the respondents. To assure that common method variance is not of great concern and thus is unlikely to confound the interpretations of our results, we performed three analyses.

First, Herman's one-factor test was conducted, where a single factor if accounts for a higher proportion of variance, suggests common method bias (Podsakoff et al., 2003). The exploratory factor analysis revealed that the single factor accounts for only 29 percent of the total variance. Which is less than 50 percent of the total variance explained (74 percent), thus, no general factor was apparent.

Second, we conducted the model fit tests by performing a confirmatory factor analysis (CFA), where all variables are loaded on a single factor and if the results show a better model fit than original model fit, suggests a common method bias (Fornell and Larcker, 1981; Podsakoff et al., 2003). All the five variables were loaded on one factor to examine the CFA model fit. The single-factor model produced a worse model fit (chi-squared statistic/degrees of freedom (χ^2/df) = 7.976, comparative fit index (CFI) = 0.781, goodness of fit index (GFI) = 0.761, root mean squared error approximation (RMSEA) = 0.13 and standardized root mean square residual (SRMR) = 0.11). The threshold criteria for a good model fit should meet following criteria; χ^2/df < 3, CFI > 0.80; GFI > 0.95; RMSEA<0.05, and SRMR<0.09 (Hu and Bentler, 1999). Our hypothesized model clearly outperformed one factor model configuration in terms of discriminant validity – as evidenced by significant chi-square reductions – and model fit standards (χ^2/df = 1.965; CFI = 0.95; GFI = 0.87; RMSEA = 0.05; SRMR = 0.04).

Third, studies suggest that the presence of common method bias can undermine the significance of interaction coefficient (Siemsen et al., 2010). Our results indicate the existence of significant levels of interaction terms in our study, suggesting minimum

common method bias. Altogether, the results of aforementioned analyses suggest that the threat of common method bias is minimal in this study.

5.2. Hypothesis and structural model assessment

The developed hypothesized relationships were tested by conducting a bootstrap analysis with 5000 subsamples. The effect size and R^2-values of these relationships were also evaluated. The baseline model presents all direct effects on endogenous constructs, including all control variables and excluding moderators (formalisation and environmental complexity). Model 1 shows the results of baseline model with the inclusion of the link between formalisation and operational agility. Model 2 tests for the second hypothesis (H2) by adding the interaction term to model 1. Model 3 further includes the link between environmental complexity and speed to market. Finally, Model 4 adds the interaction term to model 3 to test the third hypothesis (H3). Table 4 presents the results of our analysis.

To test the first hypothesis (H1), we performed a mediation analysis following the recommendation of Zhao et al. (2010) and Nitzl et al. (2016). The empirical analysis reveals the direct effect in the baseline model between IT ambidexterity and speed to market to be significant ($\beta = 0.389$, $p_{one\text{-}tailed} < 0.001$). The indirect effect between IT ambidexterity and speed to market was significant at 0.01 level while the direct effect was significant at 0.001 level with a higher beta value, which suggests partial mediation of operational agility in the impact of IT ambidexterity on speed to market (Nitzl et al., 2016). Table 5 presents a comparison of indirect effects, direct effects, and total effects to check for mediation. To further ascertain the mediating relationship, we conducted the Sobel (1982) standard errors test[16]. The mediation effects revealed from Sobel test ($\beta = 0.121$, $p_{one\text{-}tailed} < 0.01$) confirmed the proposed mediation relationships to be significant. Thus, the mediation hypothesis (H1) is

[16] Sobel test is recommended to conduct mediation analysis for the studies that have large sample size. Our sample size of 292 firms represents an adequate sample size to suggest that the mediation results of Sobel test are reliable.

supported[17]. Regarding H2, contrary to our expectations, the moderator role of formalisation on the relationship between IT ambidexterity and operational agility is not significant ($p_{one\text{-}tailed} > 0.05$, model 2). However, the inclusion of environment complexity in model 3 and model 4 reveals that the moderating role of formalisation becomes significant ($\beta = 0.183$, $p_{one\text{-}tailed} < 0.01$). Thus, H2 is validated for firms in complex environments. Regarding H3, our results support the hypothesis and show that the effect of operational agility on speed to market is amplified more intensely under the influence of environmental complexity ($\beta = 0.201$, $p_{one\text{-}tailed} < 0.01$, model 4).

The R^2-values of 0.19, 0.33, 0.67 indicate a weak, moderate and strong explanatory power of the model (Chin, 2010; Benitez-Amado et al., 2015). The R^2-values for operational agility and speed to market range from 0.210 to 0.348 and from 0.294 to 0.414 respectively, which indicates a moderate-substantial explanatory power. The f^2-value provides the relative size of each incremental link introduced in the model. The f^2-values of 0.02, 0.15 and 0.35 indicate a weak, medium or large effect size (Leal-Rodríguez et al., 2014; Braojos-Gomez et al., 2015). The f^2-values in our proposed model ranged from 0.004 to 0.271 for our models, indicating weak to large effect sizes between model variables. Table 4 provides an overview of effect sizes for all relationships.

Finally, we conducted the confirmatory composite analysis to evaluate the goodness of model fit for our structural model. The goodness of fit model was tested by evaluating the unweighted least squares (ULS) discrepancy (d_{ULS}) and geodesic discrepancy (d_G) between empirical correlation matrix and the model-implied correlation matrix of the estimated model (Henseler, 2015; Benitez-Amado et al., 2017) and also through standardized root-mean-squared residual (SRMR) value that should be lower than 0.080. The SRMR value of the

[17] To check the robustness of a covariance based structural equation modelling technique, we repeated the same tests in ordinary least squares (OLS) using Stata IC, and achieved consistent results.

proposed model was 0.029 and all discrepancies were below the 95%-quantile, suggesting the proposed structural model fits the data well. Table 6 presents the correlation matrix.

Table 4: Results for structural model evaluation.

Dependent variable → Independent variable	**Baseline model**		**Model 1**		**Model 2**		**Model 3**		**Model 4**	
IT ambidexterity → Operational agility	0.461*** (8.903) [0.323, 0.558]		0.390*** (5.669) [0.203, 0.522]		0.401*** (5.735) [0.243, 0.590]		0.425*** (5.819) [0.199, 0.601]		0.441*** (5.955) [0.257, 0.591]	
Operational agility → Speed to market	0.255*** (3.992) [0.085, 0.378]		0.255*** (3.991) [0.085, 0.378]		0.254*** (3.997) [0.089, 0.375]		0.263*** (4.104) [0.077, 0.411]		0.374*** (5.666) [0.175, 0.508]	
IT ambidexterity → Speed to market	0.389*** (5.720) [0.210, 0.517]									
Formalisation → Operational agility			-0.121* (-1.639) [-0.198, 0.133]		-0.110 (-1.181) [-0.188, 0.047]		-0.113 (-1.179) [-0.188, 0.043]		-0.092 (-0.958) [-0.054, 0.037]	
Formalisation x IT ambidexterity → Operational agility					0.196 (1.410) [0.014, 0.236]		0.183** (1.986) [0.054, 0.387]		0.195** (2.373) [0.017, 0.334]	
Environmental complexity (EC) → Speed to market							-0.103* (-1.876) [-0.074, 0.283]		-0.112* (-2.193) [-0.287, -0.011]	
EC x operational agility → Speed to market									0.201** (2.875) [0.012, 0.389]	
Firm size (control variable) → Speed to market	0.126† (2.344) [0.097, 0.281]		0.126† (2.394) [0.095, 0.281]		0.127† (2.340) [0.089, 0.280]		0.128† (2.355) [0.088, 0.296]		0.121† (2.374) [0.085, 0.293]	
Firm age (control variable) → Speed to market	0.096 (0.460) [-0.121, -0.133]		0.096 (0.465) [-0.121, 0.134]		0.091 (0.358) [-0.195, 0.113]		0.095 (0.462) [-0.120, 0.133]		0.091 (0.358) [-0.128, 0.124]	
Industry (control variable) → Speed to market	-0.059 (-1.187) [-0.188, 0.041]		-0.051 (-1.189) [-0.186, 0.082]		-0.050 (-1.189) [-0.186, 0.083]		-0.060 (-1.183) [-0.187, 0.041]		-0.052 (-1.004) [-0.177, 0.050]	
Endogenous variable	**R^2**	**Adj. R^2**	**R^2**	**Adj. R^2**	**R^2**	**Adj. R^2**	**R^2**	**Adj. R^2**	**R^2**	**Adj. R^2**
Operational agility	0.213	0.210	0.223	0.217	0.265	0.258	0.306	0.292	0.356	0.348
Speed to market	0.306	0.294	0.321	0.314	0.351	0.347	0.396	0.377	0.420	0.414
SRMR value	0.018		0.024		0.026		0.024		0.029	
SRMR HI_{95}	0.032		0.028		0.032		0.028		0.047	
d_{ULS} value	0.007		0.016		0.025		0.027		0.048	
d_{ULS} HI_{95}	0.021		0.023		0.036		0.031		0.122	
d_G value	0.001		0.004		0.006		0.008		0.014	
d_G HI_{95}	0.004		0.006		0.011		0.012		0.041	
f^2										
IT ambidexterity → Operational agility	0.271		0.264		0.261		0.263		0.265	
Operational agility Speed to market	0.170		0.169		0.171		0.178		0.181	

IT ambidexterity → Speed to market	0.131				
Formalisation → Operational agility		0.128	0.110	0.095	0.065
Formalisation x IT ambidexterity → Operational agility			0.073	0.113	0.142
Environmental complexity (EC) → Speed to market				0.071	0.045
EC x operational agility → Speed to market					0.164
Firm size (control variable) → Speed to market	0.043	0.042	0.051	0.051	0.062
Firm age (control variable) → Speed to market	0.018	0.013	0.013	0.012	0.013
Industry (control variable) → Speed to market	0.005	0.005	0.004	0.006	0.007
Note: t-values in parentheses. Bootstrapping 95% confidence interval bias corrected in square bracket (based on n = 4999 subsamples). $^{\dagger}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ [based on n = 4999, one-tailed test]					

Table 5: Results of mediation analysis.

Relationship	Indirect effect	Direct effect	Total effect
IT ambidexterity → Speed to market Baseline model (Partial Mediation)	0.193^{**} (3.615) [0.037, 0.184]	0.389^{***} (5.720) [0.210, 0.517]	0.401^{***} (8.783) [0.349, 0.612]
IT ambidexterity → Speed to market Model 2 (Partial Mediation)	0.191^{**} (3.278) [0.034, 0.185]	0.371^{***} (4.991) [0.278, 0.451]	0.402^{**} (8.549) [0.344, 0.609]
IT ambidexterity → Speed to market Model 4 (Partial Mediation)	0.195^{**} (3.874) [0.057, 0.332]	0.355^{**} (2.809) [0.085, 0.391]	0.413^{**} (7.423) [0.300, 0.592]

Table 6: Correlation matrix.

	1	2	3	4	5	6	7	8
1. IT ambidexterity	1.000							
2. Operational agility	0.462^{**}	1.000						
3. Formalisation	0.388^{**}	0.351^{**}	1.000					
4. Environmental complexity	0.264^{**}	0.350^{**}	0.258^{**}	1.000				
5. Speed to market	0.312^{**}	0.431^{**}	0.371^{**}	0.304^{**}	1.000			
6. Ln firm size	0.230^{**}	0.152^{**}	0.473^{**}	0.378^{**}	0.192^{**}	1.000		
7. Ln Firm age	$0.149^{\dagger}$	0.098^{*}	0.153^{**}	0.058	$0.123^{\dagger}$	0.379^{**}	1.000	
8. Industry	0.073	$0.102^{\dagger}$	0.091	0.213^{*}	-0.083	0.056	0.040	1.000

5.3. Post hoc multi-group analysis

We performed a post hoc multi-group analysis to explore whether the evaluated results differ significantly between firms under high environmental complexity and firms under lower environmental complexity. Following Edwards and Lambert (2007), we split the data in a lower environmental complexity group (less than one standard deviation below the mean, n = 126) and a higher environmental complexity group (greater than one standard deviation above the mean, n = 129). The results show that there is a significant difference in the moderating effect of formalisation in both settings ($p < 0.01$). Thus, the moderating role of formalisation (H2) is significantly evident in highly complex environments. Table 7 presents the results of the multi-group analysis.

Table 7: Post hoc multi-group analysis.

Effect	Firms with low environmental complexity (n = 126)	Firms with high environmental complexity (n = 129)	Was the difference in the beta coefficient statistically significant?
IT ambidexterity → Operational agility	0.392*** (4.505) [0.161, 0.569]	0.456*** (4.381) [0.192, 0.663]	No (not significant)
Operational agility → Speed to market	0.181** (2.914) [0.023, 0.331]	0.559*** (7.861) [0.373, 0.674]	No (not significant)
Formalisation → Operational agility	-0.131 (-0.849) [0.017, 0.306]	-0.114 (-0.997) [0.051, 0.904]	No (not significant)
Formalisation x IT ambidexterity → Operational agility	0.151† (1.434) [0.093, 0.219]	0.213** (3.740) [0.103, 0.344]	Yes ($p < 0.01$)
Firm size (control variable) → Speed to market	0.107† (0.962) [0.021, 0.135]	0.119† (1.026) [0.121, 0.349]	No (not significant)
Firm age (control variable) → Speed to market	0.071 (0.585) [0.039, 0.221]	0.053 (0.415) [0.109, 0.247]	No (not significant)
Industry (control variable) → Speed to market	-0.050 (-0.619) [-0.259, 0.110]	-0.026 (-0.214) [-0.301, 0.159]	No (not significant)

6. Discussion and conclusions

6.1. Implications and key contributions to IS research

Despite the important influence of IT capabilities on speed to market, empirical evidence for the underlying mechanisms is scarce. To address this gap, this study has explored the role of operational agility in the relationship between firms' IT capability and speed to market. Our findings suggest that IT ambidexterity enhances speed to market by facilitating operational agility and that the operational agility has a stronger impact on speed to market in complex environments. Moreover, we found that the moderating effect of formalisation on the link between IT ambidexterity and operational agility is only evident in complex environments. The theoretical development of our model applies the emerging perspective of ambidexterity in IT research to extend a more comprehensive understanding of how the presence of superior IT capability within a firm can improve outcomes.

This study contributes to IS literature in three ways. First, the key contribution lies in the theoretical extensions of the extant IT-enabled speed to market creation literature by providing an advanced nomological model of the relationships among IT capability, organisational setting, operational flexibility, speed to market, and environmental conditions. Drawing on the IT-enabled organisational capability perspective, the study contributes to the research on the business value of IT by empirically illustrating how an IT ambidexterity capability enables the creation of flexible and responsive operational processes, which consequently have a positive impact on speed to market. With an enhanced IT capability – the simultaneous pursuit of IT exploration and exploitation, a firm is more capable to sense and swiftly adapt its operational processes to meet the changing demands of customers. This view is consistent with the hierarchical organisational capabilities perspective (Grant, 1996) where lower order functional capabilities (IT ambidexterity and operational agility) combine to develop higher-order sustainable competitive advantage (D'Aveni et al., 2010). In this

light, IT ambidexterity capability can be considered to provide a digitized platform that facilitates the building of operational capabilities, such as operational agility, which, in turn, enable higher-order competitive manoeuvres, such as speed to market. The resulting empirical evidence can yield further insights into the business value of IT ambidexterity.

Second, this research contributes to the transdisciplinary literature (IS and Operations Management) by empirically investigating the synergistic value that is realized when IT and operational capabilities are linked. Particularly, in driving speed to market, the literature on IT ambidexterity and operational agility has evolved separately. This study seeks to close this gap by interpreting IT ambidexterity and operational agility as the consistent goals. Moreover, this research can be interpreted as an incremental extension to the prior studies of Acur et al. (2010) and Lee et al. (2015). Acur and his colleagues examined the effect of two distinctive IT capabilities – technological alignment and technological competence – on speed to market and reported a negative and a positive relationship respectively (Acur et al., 2010). Our research extends their work by offering an ambidextrous approach in such distinctive IT capabilities and highlighting the intermediating IT-enabled capability that provides a stronger impact on speed. Lee et al. (2015) suggest that IT ambidexterity enhances organisational agility by facilitating operational ambidexterity. We build on their work to examine the mediating role of operational agility with the effect of organisational setting (formalisation) on delivering a competitive outcome, speed to market, in complex environments. The resulting theoretical arguments can yield further insights into the business value of linking IS and Operations strategies.

Third, our findings contribute to the limited research on the importance of organisational settings and environmental factors in implementing IT-enabled competitive manoeuvres. While the majority of studies focusing on IT-enabled organisational capabilities examine its impact on performance measures, few have taken into consideration the role of

organisational practices and exogenous factors (Ravishankar et al., 2011; Tan et al., 2017). Our study contributes to filling this gap with an empirical examination of the moderating role of formalisation and environmental complexity in the relationships between IT ambidexterity and operational agility, and between operational agility and speed to market respectively. The results identify formalisation as a significant contributor to IT ambidexterity in developing operational agility when environmental complexity is high rather than low. In other words, when a firm perceives greater uncertainty and has greater information processing requirements, formalisation supports employees' to transform IT exploration and exploitation activities to sense and seize business opportunities by swiftly changing operational and production processes. The results also indicate that operational agility provides an added boost to speed to market in more complex environments, thus highlighting the value of operational agility in an uncertain market. Overall, our study suggests that it is vital to include firm's endogenous and exogenous factors in inferring the effect of IT capability.

6.2. Limitations and future research directions

Inevitably, this research has also some limitations. First, the results of our research are based on cross-sectional data and it is important to realize the issue with perceptual nature of the study's data (Bowen and Wiersema, 1999). We acknowledge the use of longitudinal or experimental research that may provide a better understanding of nomological relationships among research variables. Second, our sample can be generalised to high-tech SMEs in the UK market. Although we controlled for the industry, the proposed theory may behave differently from industry to industry. Moreover, we have not explored if the proposed theoretical model is supported in high-tech SMEs of other markets (i.e., Asia, Europe, and Latin America). Third, we examined IT ambidexterity capability at the firm level. We acknowledge that IT ambidexterity may occur at the level of individuals, or departments, thus our firm-level observations might present a relatively coarse representation of the nature and

impact of this IT capability. Despite the fact that our key respondents were from top management, suggesting that our results provide valid truths about the firms' use of IT, future research should also study IT ambidexterity at the level of individuals, or departments. Fourth, our study used subjective measures of speed to market. Even though the prior studies suggest that the subjective measures relative to competitors correlate with objective measures with great reliability, future research can augment this by using objective measures. Finally, despite the fact that our theoretical model is logical and our measurement and structural model analysis presented a good model fit, it proposed model could be extended by investigating additional or alternative mediators and moderators. For example, Lee et al. (2016) suggest comparative settings of manufacturing and service industries to evaluate the influence of IT capabilities on agility. Similarly, Fang (2008) suggests the role of customer participation in delivering accelerated speed to market. We hope that further research will utilize, refine and extend the findings of this study to contribute to a better theory of IT-enabled organisational capability to enhance speed to market.

6.3. Implications for managers

Our research findings provide three key lessons for IS executives. First, our findings suggest that IT ambidexterity plays a fundamental direct and indirect role in generating competitive manoeuvres. This highlights the importance of developing a balanced approach to IT management practices. That is to continually refine and extend existing IT resources, IT practices for current market needs, at the same time, explore better, and innovative IT solutions for future markets in order to achieve competitive outcomes. For example, R&D labs at Nokia and Research in Motion overtook Motorola's market share in cell phone division in the third quarter of 2008 due to their ability to develop better product mix for current and future cell phone markets (Chandrasekaran et al., 2012). Second, our results indicate that the enhanced influence of IT ambidexterity on speed to market can be achieved

through a mediating effect of operational agility. Thus, managers should strive to guarantee that IT ambidexterity capability is channelled through important operational processes of the firm. Third, this research highlights the important role played by organisational setting and environmental complexity in realizing the optimum implementation of IT capability. In particular, results suggest that firms in complex environments should focus their efforts on the development and integration of their IT capabilities with operational processes to maximize speed to market. Furthermore, in order to supplement the IT capability implementation and integration under complex environments, the managers can rely on developed practices and standards.

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CHAPTER 6

CONCLUSION

Chapter 6 | Conclusion

1. Summary

Since Carr (2003) review article 'IT doesn't matter', the research into the value generation of IT resources has become a thematic line of enquiry in the IS literature. At present, IS researchers face mounting pressures to address questions concerning whether and how IT resources lead to the creation of business competitiveness. Developing on the strategic management of IT resources and technological advances to enhance firm competitiveness, the IS literature identifies IT ambidexterity. IT ambidexterity, defined as the ability of a firm to exploit and explore IT resources simultaneously (Lee et al., 2015), is a socially complex, casually ambiguous and imperfectly imitable resource that ensures long-term firm survival and competitive advantage (Subramani, 2004; Mithas and Rust, 2016; Heckmann, 2015). Despite its importance, it appears that in the IS research field, there is a dearth of literature focusing on IT ambidexterity and perhaps surprisingly, research on initiating mechanisms to IT ambidexterity is almost non-existent.

Moreover, literature on organisational ambidexterity reveals that the ambidexterity debate has focused predominantly on large firms, with comparatively scant attention paid to SMEs, particularly high-tech SMEs. It is widely acknowledged that high-tech SMEs are the driving engines of most economies. High-tech SMEs have a strong technological innovation imperative and are expected to employ approximately 40 percent of high proficiency workers i.e. programmers, scientists and engineers (Bharati and Chaudhury, 2015), thus, contributing significantly to national gross domestic product (GDP) growth (Oke et al., 2007). Their survival and growth is imperious. For example, United Kingdom is, apart from USA and Taiwan, one of the most important supply centres of high-tech products in the world (Tsai and Yang, 2013; Oke et al., 2007). As the annual report on European SMEs states, UK high-tech SMEs post the strongest combined performance in value added and performance growth

(Muller et al., 2014). It is thus important to examine and understand the specific capabilities that enable IT ambidexterity in high-tech SMEs.

Furthermore, prior research, though not specifically in the high-tech SMEs context, has attempted to explore the role of IT ambidexterity in enhancing firm performance e.g. (Subramani, 2004; Lee et al., 2015; Mithas and Rust, 2016). Interestingly, the literature seems to indicate conflicting opinions about the role of ambidexterity on SME performance. In contrast with Lubatkin et al. (2006) more positive pronouncements on the role of ambidexterity capability, Raisch and Birkinshaw (2008), for instance, suggest that that ambidexterity might become a performance-constraining strategy for SMEs due to resource limitations. Although several studies have investigated competitive IT frameworks in the high-tech SME context, our understanding of whether IT ambidexterity is, in fact, a relevant strategy to enable superior new project performance in high-tech SMEs remains limited. Therefore, understanding whether and how IT ambidexterity helps high-tech SMEs to gain business advantage remains enigmatic.

We believe that an examination of IT ambidexterity capability in high-tech SMEs will not only help in the rigorous academic clarification of the question 'Does IT matter?' (Carr, 2003), but will also help owners/managers of a growing number of these firms in the UK determine whether they should consider making investments in IT ambidexterity. This leads to our primary research question:

What mechanisms allow high-tech SMEs to enable IT ambidexterity, and whether IT ambidexterity is in fact a relevant strategy to enable superior performance in high-tech SMEs?

This main research question is further split into sub-questions, which guided this study in finding an answer to the main question, but also addressed the following specific research gaps in our current understanding of the IT ambidexterity concept:

- *RQ1: what are the enabling mechanisms for firms to develop IT ambidexterity?*
- *RQ2: Does IT ambidexterity influence firm's project performance?*
- *RQ3: How might different decision-making styles influence high-tech SMEs' leaders to enable IT ambidexterity?*
- *RQ4: How does organisational diversity and shared vision influence the strength of the relationship between leadership decision-making styles and IT ambidexterity?*
- *RQ5: How does IT ambidexterity affect IT performance?*
- *RQ6: How do firms' internal and external contingencies moderate the IT ambidexterity-IT performance relationship?*
- *RQ7: How does IT ambidexterity effect speed to market within a firm?*
- *RQ8: Would the relationship between IT ambidexterity and an IT-enabled mechanism to enhance speed be strengthened in the firms that are formalised?*
- *RQ9: Whether environmental complexity influences the role of IT-enabled mechanism in delivering speed to market?*

The different chapters in this thesis address these specific research gaps identified in the current IT ambidexterity and IS literature.

2. Main findings by chapters

Raisch et al. (2009) identify that literature on ambidexterity often adopts a fragmentary or piecemeal approach neglecting exploitation-exploration tensions across different levels of the firm. Therefore, Chapter two attempts to overcome the limitation of the prior studies that do

not recognise the multilevel nature of ambidexterity by arguing that SMEs benefit from two distinct capabilities – leadership versatility and configurational flexibility – at a different organisational level to develop IT ambidexterity. A versatile decision-making capability helps senior-level SME managers to resolve the contradictory tensions that occur when making IT exploitation and IT exploration decisions and resource allocation. A configurational flexibility allows IT exploitation and IT exploration projects to coexist within the same physical setting. Thus, chapter two proposes strategic decision-making level and structural implementation level capabilities to enable IT ambidexterity and to test whether IT ambidexterity enables superior new project performance in high-tech SMEs. The empirical analysis suggests that leadership versatility and configurational flexibility assist firms in developing IT ambidexterity and that IT ambidexterity is indeed a significant contributor to enhance projects performance. We also find that IT ambidexterity partially mediates in the impact of leadership versatility on project performance and fully mediates the relationship between configurational flexibility and project performance.

Although ambidexterity has a positive influences on sustained growth and competitiveness of firm (Raisch et al., 2009), it may continuously challenge firm leaders to make decisions in order to manage the contradicting and paradoxical demands that are inherent to exploitation and exploration activities (Jansen et al., 2008; Carmeli and Halevi, 2009) because the routines, structures, processes and skills required for exploitation are fundamentally different from those required for exploration (O'Reilly and Tushman, 2008). To better understand how leaders manage these paradoxes of IT ambidexterity, Chapter three focuses on leadership decision-making styles (directive decision-making (DDM) and participative decision-making (PDM)) as an imperative tool. Moreover, drawing on the contingency theory of leadership, chapter three examines how and when leadership decision-making styles might be more or least effective by considering organisational diversity and shared vision as two important

contingencies. The findings identify that, interestingly, both leadership DDM and leadership PDM styles enable IT ambidexterity. Although the two leadership styles may achieve the same end, the mechanisms or means may be quite different. A leadership DDM style operates on providing firm members with guidance regarding goals, means of achieving goals, performance standards, and monitoring and providing appropriate feedback. A leadership PDM style, however, operates on the principles of developing the firm member's sense of autonomy and responsibility. Moreover, the findings caution organisational leaders to consider adopting decision-making styles to synergise with the levels of organisational diversity and shared vision. A leadership PDM style is preferable within the context of a highly diverse or heterogeneous workforce, whilst if shared vision is a dominant factor in the firm, adopting a leadership DDM style could be more effective. Finally, the results show that high-tech SMEs should take advantage of IT ambidexterity in order to develop and sustain overall firm performance (measured in terms of competitive position, sales growth, average profit per customer, and return on investment).

To explicate the effect of IT ambidexterity on IT performance, Chapter four draws on a combination of the resource-based view and contingency theory to develop a conceptual framework that investigates the moderating effects of a firm's internal and external contingencies on the IT ambidexterity-IT performance relationship. The internal contingencies include firm size and firm age, whereas, external contingencies include environmental dynamism, environmental munificence, and environmental complexity. The findings suggest that the positive effect of IT ambidexterity on IT performance is amplified in the firms possessing more resources and with higher levels of environmental dynamism, complexity, and munificence. Interestingly, our results show that the performance implications of IT ambidexterity are not age-dependent, suggesting, therefore, that, IT ambidexterity can be as advantageous for new entrants as it would be for incumbent firms.

Speed to market is becoming an important weapon for competitive advantage in today's competitive, fast-changing consumer preferences and complex market environments. Although numerous studies document the positive effect of IT capabilities on speed to market, the enabling effects of IT ambidexterity has received little attention. Chapter 5 draws on the theory of IT-enabled organisational capabilities perspective; this study proposes that IT ambidexterity enhances speed to market by facilitating operational agility. This relationship is tested using a model in which operational agility mediates the link between IT ambidexterity and speed to market under varying conditions of organisational formalisation and environmental complexity. The results uncover a positive and significant link between IT ambidexterity and operational agility and operational agility and speed to market. The findings also show that the effect of IT ambidexterity on speed to market is partially mediated by operational agility, that environmental complexity positively moderated the link between operational agility and speed to market, such that operational agility has a greater impact on speed to market in complex environments. While organisational formalisation moderates the link between IT ambidexterity and operational agility, the findings reveal that this moderation effect is evident in highly complex environments only.

3. Overall discussion & contributions to literature

Prior IS research on IT, and exploration and exploitation activities has mainly focused on the balanced usage of exploration and exploitation of IT resources (Subramani, 2004; Gregory et al., 2015), and the role of IT in contextual ambidexterity (Im and Rai, 2014), but it remains unclear the mechanisms that may help firms to develop IT ambidexterity capability, and a clear theoretical and empirical examination of the impact of IT ambidexterity on firm performance. High-tech SMEs have been growing rapidly over the last few years in the UK; they constantly face challenges arising from fast developing technology, short product life, and high competitive rivalry. Under such condition, SMEs require of exploring and

exploiting new IT resources to sustain IT-based competitive advantage in the market. In this sense, IT ambidexterity is a critical and idiosyncratic IT capability with the proven potential to improve organizational agility (Lee et al., 2015). What are the enabling mechanisms for high-tech SMEs to develop IT ambidexterity? Before the execution of our study, we did not have an answer for this interesting research question. Similarly, apart from study of Lee et al. (2015), there are no studies that investigate the impact of IT ambidexterity on performance outcomes. Does IT ambidexterity a relevant capability to enable superior performance in high-tech SMEs? This also seemed a research questions for which IS scholars have not been able to provide a rigorous theoretical answer. To the best of our knowledge, this study is among the first studies to empirically test the enabling mechanisms and consequences of IT ambidexterity capability for high-tech SMEs in the UK. We tried to provide answers to these research questions through a combination of theory- and data-driven empirical study. I believe this to be an important practical contribution of this research.

This dissertation contributes to the embryonic stage of IT ambidexterity literature by providing an in-depth understanding of the enabling mechanisms and consequences of IT ambidexterity in high-tech SMEs. The findings of this research contribute to the debate surrounding how to manage and organise for IT exploitation and IT exploration simultaneously within the same firm. In contrast to arguments of Tushman and O'Reilly (1996) that ambidexterity can only be enabled with separate exploration and exploitation organisational units, the mechanisms irrelevant to SMEs, this study highlights the idiosyncratic roles of organisational factors to develop IT ambidexterity under organisational context (diversity and shared vision). In addition, against the theoretical concerns that ambidexterity might become a performance-constraining strategy for SMEs due to resource limitations (Raisch and Birkinshaw, 2008), this research theoretically explains and

demonstrates empirically how firms can develop and create business value from IT ambidexterity. This is the primary contribution of this study to the IS research.

Worldwide IT investment has been projected to total $3.7 trillion in 2018, an increase of 4.5% from 2017, according to the latest forecast by Gartner Inc. (Gartner, 2018). In this sense, companies invest millions Euros in IT resources but not all of them generate the expected business benefits (Benitez et al., 2018). Prior IS research on business value of IT and IT-enabled organizational capabilities has found that the exploitation of existing IT resources and the development of current IT capabilities improves firm performance by developing organizational capabilities such as market orientation, collective mind, coordination capability, and absorptive capacity (Pavlou and El Sawy, 2006), knowledge management (Tanriverdi, 2005), proactive management (Benitez and Walczuch, 2012), corporate entrepreneurship (Chen et al., 2015), or business flexibility (Chen et al., 2017; Benitez et al., 2018). Drawn from the Lee et al.'s (2015) seminal work and extending their study, we also contribute to the IS literature on business value of IT and IT ambidexterity capability by showing how IT ambidexterity enables the high-tech SME's capability in executing competitive manoeuvres. This is the secondary contribution of this study to the field of IS.

Finally, this study responds to the call for greater attention on developing a competitive IT framework (Carr, 2003; Pavlou and El Sawy, 2006; Nambisan, 2013; Mithas and Rust, 2016). In contrast to several other constructs of IS capabilities (e.g. IT spending, IT development, and IT possession) that may not necessarily create competitive advantage due to imitability and substitutability, this study contributes to IS literature by theorising IT ambidexterity as a distinct and valuable IT capability that is hard for competitors to emulate.

4. Contributions to practice

The findings of this research provide numerous critical lessons for IT managers. First, this study show IT managers how they can develop the ability to simultaneously exploit their traditional IT resource infrastructure (e.g., enterprise systems, customer relationship management systems, human resource management systems), and exploit new digital technologies and digital capabilities (e.g., social media, mobile, analytics, cloud, and Internet of Things). Companies interested in developing this idiosyncratic IT capability should combine the usage of directive and participative leadership, as well as balancing the deployment of formal and informal configurations. Second, our findings show IT managers that when working with heterogeneous work force the significance of leadership decision-making approach becomes critical. An effective guide is to adopting a decision-making style that synergises with the levels of organisational diversity and shared vision. Participative decision-making approaches are preferable within the context of a highly diverse or heterogeneous workforce, whilst if shared vision is a dominant factor in the firm, adopting a directive decision-making approaches could be more effective. Third, the findings show that IT capability contributes through developing operational capabilities such as operational agility and managers should strive to guarantee that IT ambidexterity capability is channelled through important operational processes of the firm. Finally, this study shows IT managers that the company's efforts in both exploiting current IT resources and exploring further investment and development of new digital technologies creates business value by improving the project performance, which is critical to fulfil the current and future demands of the customers. In this sense, investments in IT capabilities matter.

5. Research limitations and future research avenues

One of the limitations arises from the specific research methodology employed. We used a cross-sectional survey technique to collect the data, where the same respondent provided an

assessment of the predictor and the criterion variables. The use of self-reported data by single key informants may have limited the inferences among construct variables due to common method variance concerns (Podsakoff et al., 2003). In order to assure that common method variance is not of great concern and thus is unlikely to confound the interpretations of our results, we performed a number of anlysis (a) the use of established measuring instruments to reduce the threats associated with common method bias (Fornell and Larcker, 1981); (b) the Harmon's single-factor test through exploratory factor analysis; (c) confirmatory factor analysis, viewed as a 'sophisticated test' of CMV (Podsakoff et al., 2003: 889); (d) introduction of market variable following Lindell and Whitney (2001) suggestions; and (e) checks for existence of significant levels of interaction coefficients terms following Siemsen et al. (2010). Although self-reported data may not essentially be flawed (Tsai and Yang, 2013), future research could survey multiple informants to collect independent and dependent variables data separately providing better methodological reliability (Jansen et al., 2006). Despite the fact that our key respondents were from top management, suggesting that our results provide valid truths about the firms' use of IT, future research should also study IT ambidexterity at the level of individuals, or departments. In addition, a longitudinal study that includes qualitative data collection would extend our findings and explore how the identified antecedents actually promote IT ambidexterity and the implications of IT ambidexterity can be better understood by comparing the performance over time. Moreover, although the choice of organisational antecedents and contingency variables used in this research are justified, the future research may also consider competitive market factors e.g. market rivalry (De Clercq et al., 2013), market positioning (Hoque and James, 2000); that may provide additional insights and further validation to role of IT ambidexterity. Furthermore, the sample of this research is industrially and geographically homogeneous that may limit the extent to which the results may be generalised. The future research can examine whether these findings hold

across large firms competing in a diverse product range. Finally in the operationalisation of ambidexterity measure the literature suggests three different combination methods; multiplicative interaction between exploitation and exploration (Gibson and Birkinshaw, 2004), absolute deviation interaction (He and Wong, 2004) and additive interaction (Lubatkin et al., 2006). The multiplicative interaction interprets ambidexterity as the ability to simultaneously explore and exploit; the absolute deviation interaction interprets ambidexterity as the ability to equally focus exploration and exploitation activities; and additive interaction intends to measure total levels of ambidexterity, without any loss of information. I have chosen to use the additive approach in chapter three and four, which showed the best explanatory power, following the methodology suggested by prior studies (Lubatkin et al., 2006; Edwards, 1994; Jansen et al., 2009) to compare combinative approaches. Notwithstanding the limitations of this research, I hope that researchers will utilise, further refine, and extend the findings of this dissertation to a better theory of IT ambidexterity.

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Appendix

Appendix A

Table: Antecedents to ambidexterity in SMEs

Author (s)	Antecedents (relevant theory)	Performance implications	Methodology
Lubatkin et al. (2006)	Top management team behavioural integration (Upper echelon theory)	Firm performance (profitability & growth)	Survey (139 firms)
Chang et al. (2011)	Internal (centralisation and connectedness) and external environments (dynamism and competitiveness)	Firm performance (customer and employee satisfaction)	Survey (265 firms)
Chang and Hughes (2012)	Organisational leadership, context and structure (2nd order constructs)	Firm performance (customer and employee satisfaction	Survey (243 firms)
Arechavala-Vargas et al. (2014)	Network-building behaviours and alliances	Firm survival and growth	Comparative case study (9 firms)
Li et al. (2014)	Top management team external social networks (Social capital perspective)	New product program performance	Survey and interviews (113 firms)
Bocquet and Mothe (2015)	Governance structure for cluster ambidexterity (Knowledge based view)	Firm innovation performance (R&D activities)	Qualitative research (2 clusters)
Kusumastuti et al. (2015)	Social support and performance management	Firm innovative capability	Mixed methods (170 firms)
Broersma et al. (2016)	Absorptive capacity and CEO strategic engagement (knowledge based view)	Firm level innovation activities	Survey (366 firms)
Zhang and Cui (2017)	Network ties – business and political (network view)	Firm innovative capability	Survey (264 firms)

Appendix B

Table: Detailed statistics on measurement items

Directive leadership (CA[18] = 0.933, CR[19] = 0.941, AVE[20] = 0.714)	Factor loadings
Our firm leader provides inspiring strategic and organisational goals.	0.912
Our firm leader appears to be a skilful performer when presenting to a group.	0.841
Our firm leader is inspirational, able to motivate by articulating effectively the importance of the task.	0.901
Our firm leader consistently generates new ideas for the future of the organisation.	0.837
Our firm leader has a vision, often brings up ideas about possibilities for the future.	0.820
Participative leadership (CA = 0.881, CR = 0.893, AVE = 0.737)	
We are fully involved with our leadership in solving problems in our firm.	0.842
We are fully involved with our leadership in initiating changes in your department.	0.911
We are fully involved with our leadership in determining the goals and tasks of our subordinates	0.920
Formal configuration (CA = 0.869, CR = 0.861, AVE = 0.565)	
Written rules and procedures occupy a central place in the organisational unit.	0.881
Firm adheres strong emphasis on getting personnel to follow formal procedures	0.714
Quality control and cost control procedures of operations are well documented.	0.865
Informal configuration (CA = 0.873, CR = 0.889, AVE = 0.651)	
In our firm, there is ample opportunity for informal "hall talk" among employees.	0.732
In this firm, employees from different departments feel comfortable calling each other when the need arises.	0.819
People around here are quite accessible to each other.	0.867
In this organisation, it is easy to talk with virtually anyone you need to regardless of rank or position.	0.831
IT Exploitation (CA = 0.903, CR = 0.921, AVE = 0.680)	
Our firm frequently refines the existing level of IT components, such as hardware and network resources.	0.810
Our firm reuse existing IT skills.	0.745
Our firm improves existing IT applications and services.	0.757
Our firm continually expands existing IT services for existing clients.	0.819

[18] Cronbach's Alpha
[19] Composite Reliability
[20] Average Variance Explained

IT Exploration (CA = 0.946, CR = 0.951, AVE = 0.663)	
Our firm pursues innovative applications of IT.	0.839
Our firm experiments and develops unique IT applications.	0.878
Our firm accepts demands that go beyond existing level of information services.	0.881
Our firm regularly searches for and acquires new IT resources (e.g., new generation of IT architecture, potential IT applications, and critical IT skills).	0.893
Our firm experiments with new IT management practices.	0.874
New project performance (CA = 0.907, CR = 0.914, AVE = 0.703)	
Adherence to schedule	0.829
Adherence to budget	0.766
Adherence to quality	0.958
Technical performance	0.916

Appendix C

Table: Details of measurement indicators

IT Exploitation (CA=0.91, CR=0.92, AVE=0.68)
Our firm frequently refines the existing level of IT components, such as hardware and network resources. Our firm reuse existing IT skills. Our firm improves existing IT applications and services. Our firm continually expands existing IT services for existing clients. Our firm frequently refines the provision of existing IT systems and IT services. **IT Exploration (CA=0.94, CR=0.95, AVE=0.66)**
Our firm pursues innovative applications of IT. Our firm experiments and develops unique IT applications. Our firm accepts demands that go beyond existing level of information services. Our firm regularly searches for and acquires new IT resources (e.g., a new generation of IT architecture, potential IT applications, and critical IT skills).

Our firm experiments with new IT management practices. Our firm seeks to provide new IT information services that are completely new in the market. **Formalisation (CA=0.91, CR=0.90, AVE=0.76)**
Written rules and procedures occupy a central place in the organisational unit. Firm adheres strong emphasis on getting personnel to follow formal procedures Quality control and cost control procedures of operations are well-documented. **Operational agility (CA=0.80, CR=0.80, AVE=0.62)**
We fulfill demands for rapid-response, special requests of our customers whenever such demands arise; our customers have confidence in our ability. We can easily reconfigure our processes to handle emerging changes. We can quickly redesign business processes to accommodate fluctuations in demand from the market. **Environmental complexity (CA=0.89, CR=0.89, AVE=0.69)**
In our industry, there is considerable diversity in customer buying habits In our industry, there is considerable diversity in product lines There has been a frequent change in firm suppliers. The legal regulations have frequently changed the way our firm conducts business. **Speed to market (CA=0.90, CR=0.90, AVE=0.71)**
New products/services have been developed and launched faster than the major competitor for a similar product. New products/services have been completed in less time than was considered normal or customary for our industry. New products/services have been launched on or ahead of the original schedule developed at initial product go-ahead. Top management has been pleased with the time it took us from specifications to full commercialization.

Appendix D

Table: Glossary with definition of key terminologies used in development of conceptual models

Terminologies	**Definition**
Ambidexterity	The ability of firms to manage differing and often competing activities at the same time to leverage their resources (Duncan, 1976).
Configuration	The arrangement or pattern of organizational routines, behaviors and everyday activities (Kang and Snell, 2009).
Diversity	The degree to which individuals within the group differ in aspects of their knowledge, expertise, demography or background (Van Knippenberg and Schippers 2007).
Exploitation	The refinement, selection, production and efficiency of existing systems (March, 1991).
Exploration	The experimentation, variation, risk-taking and search for innovative practices, procedure and systems (March, 1991).
Formalization	The degree to which organisational configuration has distinctive boundaries, enlisted priorities, detailed rules and standardized routines (Kang and Snell, 2009).
High-tech	The manufacturing and service firms in precision equipment, computer and electronic, control instrument, telecommunication, medical equipment and supplies, and optics apparatus, all of which are included in NAICS 2012 industry classification under codes 51, 54, 334, and 335.
Information technology (IT)	The technologies used to store, retrieve, transmit, utilise and manipulate data in a business context (Lin & Lin 2008).
Mechanisms	The enabling mechanisms of IT ambidexterity have been used quite often in this research. Adopted from the study of Kang and Snell (2009), the mechanisms defines the procedures, systems, operations or means by which something takes place or brought about.
Small and medium enterprises (SMEs)	Firms having up to 249 full-time employees.
Speed to market	The speed with which product is made available in the market after the stage of product definition (Vesey, 1991), also referred in literature as time to market.

Versatility	The ability to continually adjust behaviour, deftly applying the right approach, to the right degree, for the circumstances at hand (Kaplan and Kaiser, 2003).

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